SCIENCE ABSTRACTS.

Section A.—PHYSICS.

MARCH, 1926.

GENERAL PHYSICS.

421. *History of the Standard Weights and Measures of the United States.* **L. A. Fischer.** (Bureau of Standards, Misc. Publ. No. 64. [34 pp.], 1925.)—The title sufficiently indicates the contents of this paper. It is accompanied by a series of photographs of important standards both ancient and modern. A. A. D.

422. *The Original Eötvös Gravity Balance.* **D. Pekár.** (Zeits. Instrumentenk. 45. pp. 486–493, Oct., 1925.)—An account is given of the various balances designed by Eötvös for the measurement of the gravitation constant both in the laboratory and in the field and some details are given of an instrument used in India. In particular, however, the paper deals at length with the sensitivity of the various instruments. It has been maintained by Schweydar that certain instruments of this class are more sensitive than any constructed by Eötvös. Figures are here given showing that the Eötvös 1924 model is about 12 % more sensitive than Schweydar's instrument. A. A. D.

423. *Two New Types of High-Vacuum Gauge.* **E. B. King.** (Phys. Soc., Proc. 38. pp. 80–84; Disc., 84, Dec., 1925.)—Descriptions are given of a new type of decrement gauge in which the individual oscillations are photographed, and a variation of the Pirani gauge, in which no metal is exposed to the vacuum. AUTHOR.

424. *The Compressibility of Several Artificial and Natural Glasses.* **P. W. Bridgman.** (Am. J. Sci. 10. pp. 359–367, Oct., 1925.)—In a previous paper [Abstract 1063 (1924)] it was shown that the compressibility of pyrex glass increases with increasing pressure instead of decreasing as with most substances. In the present paper several artificial glasses of varying analyses, one of them with no silica and also pure silica glass, were studied to ascertain whether the effect was in some way connected with the high silica content of pyrex glass. It was found that the departure from normal behaviour was greatest for pure silica, whereas silica free glass was normal. Natural glasses were also studied, but the interpretation of the results for these is uncertain.

The table summarises the data obtained for the artificial glasses, according to the formula $AV/V_0 = ap + bp^2$ where AV/V_0 is the compressibility and p is expressed in kg./cm².

Designation of Glass.	Coefficients at 30°.		Coefficients at 75°.	
	a.	*b.*	*a.*	*b.*
Silica (quartz glass)	$26\cdot47 \times 10^{-7}$	$+17\cdot6 \times 10^{-12}$	$27\cdot74 \times 10^{-7}$	$+7\cdot17 \times 10^{-12}$
Pyrex	29·82	+ 7·0	30·08	+ 4·86
Corning #714x	27·20	+ 4·80	27·55	+ 4·9
Corning #722Q	24·03	+ 1·3	24·88	− 4·2
Corning Silica-free	16·82	− 10·2	17·20	− 10·44
Tachylite Torvaig	18·73	− 11·0	19·11	− 11·1
Pitchstone Meissen	24·95	− 5·43	24·93	− 5·67
Tachylite Kilaues	13·26	—	13·74	− 9·1

E. G.

425. *Maintenance of Pendulums by Means of Photoelectric Cells.* **G. Ferrié.** (Roy. Soc. Edinburgh, Proc. 45. 3. pp. 261–268, 1924–1925. In French.)—Further experiments are carried out on the question of possible errors introduced into the periodic times of high-precision pendulums by photoelectric cell maintenance [see Abstracts 1537, 1538 (1925)]. With a pendulum observed when so maintained and when swinging freely, the difference in periodic time is less than 1/10,000. Slight differences observed in other cases (1/1000 to 2/1000 sec.) are ascribed to details in the arrangements for registration. A. B. C. L.

426. *A New Stroboscopic Method of Great Intensity.* **L. and A. Seguin.** (Comptes Rendus, 181. pp. 539–541, Oct. 26, 1925.)—The method of intermittent illumination, using a Geissler tube worked from a Ruhmkorff coil with a synchronised interrupter, provides but a feeble intensity, and attempting to increase this by using larger currents leads to arcing at the contact, and consequently to longer duration of the flash. In the apparatus described the synchroniser is separate from the actuating circuit. A rotating or alternating contactor produces the discharge of a condenser charged to a few hundred volts through the primary of an air core transformer, and the secondary is used as a "trigger." A large battery of condensers kept continually charged by current from the secondary of an a.c. transformer, rectified by valves, is used to excite a neon tube. In the circuit, however, is a spark-gap, through which current

will just not pass without the "trigger." There being very little self-induction in the circuit, the spark is practically instantaneous; two lines 1 mm. apart on the rim of a wheel, moving at 100 m./sec. being clearly distinguished. The intensity is great enough to illuminate a whole room, and the room need not be darkened. It is also suggested that if concentrated illumination is needed, the neon tube may conveniently have the form of the caustic of the optical system employed.
W. G. B.

427. *"Chronostroboméètre" and Measuring Frequency of Rotation.* **A. Guillet.** (Comptes Rendus, 181. pp. 707–709, Nov. 16, 1925.)—It is possible to obtain by a direct reading and at a given moment an exact measure of the frequency of rotation or oscillation by using the chronometric motor [see Abstract 1718 (1923)] for stroboscopic observation of the machine whose rate is desired. Such a motor gives a fundamental frequency, which is permanent and constant, by its regulating tuning-fork. The author gives modes of measuring the frequency of rotation of a given motor whose axis carries an index perpendicular to it; the first has a bedplate pierced with holes through which the index is viewed, the positions of the index, caught by the eye, forming a star which in practice need have only two or three rays; the other modes are variants or extensions of the first. In measuring the frequency it is not necessary to define the images as in the study of the working of a machine. A. S. D. M.

428. *Theory of Diffusion Air-pumps.* **W. Molthan.** (Phys. Zeits. 26. pp. 712–717, Nov. 16, 1925. Paper read before the Deut. Physikertag., Danzig, Sept., 1925.)—A discussion, illustrated by numerous figures and diagrams, of the comparative merits of mercury-vapour jet and diffusion pumps leads to the conclusion that the essential difference between these two types of pumps is as follows: If in the jet pump air be mixed with the vapour, the jet of mixed air and vapour exhausts the air as efficiently as a pure vapour jet, whereas under like conditions the diffusion pump fails to produce a high vacuum. In the vapour jet pump the vacuum is produced dynamically by the weight of the vapour, but in the diffusion pump the vapour steam washes away the air which diffuses from the receiver, much in the same way as running water removes the salt solution from tanned leather. The essential result of these investigations is that with the usual diffusion pumps with very great vapour velocities the important constants, free molecular path and suction efficiency can now be calculated. The detailed mathematical working is reserved for a future paper. E. F.

429. *On the Design of the Kew Pattern Barometer.* **Sachindra Nath Sen.** (Meteorolog. Office, Geophys. Mem. No. 27. pp. 203–225, 1925.)—A graphical method of finding the bore of the barometer tube at the top when the length of a scale division and the diameter of the cistern are known is described. It is proved that, in a marine barometer having a straight piece of capillary of uniform bore, the "falling time" is logarithmic and varies directly as the cross-section of the tube at the top and the length of the capillary and inversely as the square of the capillary cross-section.

In verification of the theory an experimental Kew pattern barometer has been made, the special features of which are: (i) A large flat cistern fitted with a device for accurately adjusting the standard temperature of the barometer; (ii) a barometric scale almost as open as that of the Fortin barometer; (iii) a straight piece of capillary of definite length and known cross-section; (iv) the "falling" and "lagging" times are in accordance with Stokes' theory and the instrument is portable.

The data set out in the paper give practically unlimited choice in the various dimensions of the component parts of the tube of the Kew pattern barometer. A specification of the Kew pattern barometer has been drawn up, removing the distinction between the cross-section of the tube at the top in the station and marine types. AUTHOR.

430. *The Ostwald Viscometer as a Consistometer.* **W. H. Herschel and R. Bulkley.** (J. Phys. Chem. 29. pp. 1217–1223, Oct., 1925.)—The Ostwald viscometer is used in the East Indies rubber experimental station for determining the consistency of benzene solutions of crude rubber. The method of determining the mean effective head was examined, and it was found that the error was less when the average head was assumed to be equal to the arithmetical mean with spherical bulbs than with cylindrical bulbs. The viscometers were calibrated by the use of water and benzene, both under hydrostatic pressure and external pressure. It was shown that the Ostwald viscometer may be used for varying rates of flow, by applying external pressure, and hence may be employed to measure the consistency of apparently liquid materials which are known or may prove to be plastic. In order to measure plasticity a sufficient number of readings must be taken at various rates of flow to determine with sufficient accuracy the relation between rate of flow and the pressure which produces it. F. J. B.

431. *Diffusion Experiments with Liquids.* **R. Fürth.** (Phys. Zeits. 26. pp. 719–722, Nov. 16, 1925. Paper read before the Deut. Physikertag., Danzig, Sept., 1925.)—Results so far obtained are theoretically and practically faulty. Owing to the slowness of diffusion in liquids an experiment may last several days, during which time the temperature in the apparatus must be kept constant. This renders the establishment of diffusion coefficients very difficult, if not impossible. Most of the methods hitherto employed assume a definite law of diffusion devoid of experimental foundation. The problem is to devise methods which avoid these faults and enable us to determine the law of diffusion and establish the diffusion coefficients quickly and correctly. The methods here described and illustrated by figures solve the problem by observing the course of diffusion on a microscopic scale. By diminishing the measurements X of the diffusion vessels the time of observation T is so shortened that X^2T is approximately constant. Reducing X to one hundredth, T is shortened to ten-thousandth, *i.e.*, from several days to a few minutes. No definite law of diffusion is assumed as a basis, and the aforesaid sources of error are eliminated. The results are worked out mathematically. It is not yet possible to deduce the actual form of the law of diffusion, and the experiments will be continued with improved apparatus. E. F.

432. *The Spreading of Lubricants over Solid Metal Surfaces.* **P. Woog.** (Comptes Rendus, 181. pp. 772–774, Nov. 23, 1925.)—While on water and mercury the unsaturated (active) oils spread more rapidly, on solid metal surfaces the reverse is the case. The explanation is that the active molecules at the edge form a barrier anchored, as it were, to the comparatively immobile metal molecules. This explains why a purely mineral oil has, as has long been known, proved unsatisfactory as a lubricant for clocks and chronometers. A small percentage of an active oil enables the bearing to hold the lubricant. W. G. B.

433. *Viscosity of Some Alloys when Hot.* **J. Cournot** and **K. Sasagawa.** (Comptes Rendus, 181. pp. 661–662, Nov. 9, 1925.)—It has been found that when an alloy is stressed at high temperatures, it elongates at a rate ultimately constant, depending upon the temperature and the stress, but there is a limiting stress depending upon the temperature below which the flow does not occur. At 600° C., the stress to produce a rate of $1{\cdot}6 \times 10^{-3}$ mm./hr., in a test piece 10 cm. long and 1 sq. mm. in section, varies from about 5 kg./sq. mm. for mild steel to 16 for high-speed tungsten steel, and to above 30 for iron-nickel-chromium alloy and silicon-chromium steel. As the temperature rises the limit of viscosity falls rapidly, but the alloy iron-nickel-chromium is markedly less fluid than the others above 600° C. W. G. B.

434. *A Kinetic Theory of the Viscosity of Liquids.* **M. Satô.** (Tôhoku Univ., Sci. Reports, 14. pp. 403–444, Oct., 1925.)—The viscosity of liquids decreases with rise of temperature, and so the mechanism causing it must be quite different from the simple transfer of momentum which explains that of gases. The present paper attempts to explain it in terms of the mutual action between molecules, transfer of momentum playing only a small part. The molecule is considered as a dipole, a model which has yielded other results in the hands of Debye and Born. To enable impacts to be treated comparatively simply, the molecule is imagined to be a pair of small spheres joined by a rod. The effect of transfer of momentum will be a tendency to turn the molecules so that their axes are parallel to the direction of flow. This is resisted by the mutual attractions and repulsions. By lengthy mathematical argument, formulæ are deduced giving the viscosity as a function of temperature. These formulæ are applied to ethyl and methyl alcohols for ranges 0°–70° C., and 0°–60° C. respectively, and the calculated and observed values agree to within 4 % over these ranges. W. G. B.

435. *Viscous Flow through Wide Angle Cones.* **W. N. Bond.** (Phil. Mag. 50. pp. 1058–1066, Nov., 1925.)—Theory (neglecting terms depending on the square of the velocity and assuming purely radial flow) shows that the flow is reversed when the semi-angle α of the cone of fluid is greater than $\frac{\pi}{2}$ along radii making angles greater than $\pi - \alpha$ with the axis, while the radial pressure gradient is reversed along radii making angles greater than $\sin^{-1}\sqrt{\frac{2}{3}}$. Experiments were performed to test these predictions. Glycerine containing a small amount of water, and shaken to obtain a number of air bubbles, flowed under gravity in a cubical tank, the base of which was plane or conical with semi-vertical angles 110°, 141°, or 160°. Two sides of the tank were of glass, and a parallel beam of light entering through a vertical slit illuminated the air bubbles in an axial plane. Photographed by intermittent exposure, each bubble yielded a number of dashes, enabling the velocity at various points to be measured. For $\alpha = 90°$ predictions were verified, but for greater angles the reversal of velocity produced a ring eddy, and the velocity was no longer purely radial. The pressure gradient was measured for $\alpha = 90°$, and was found to be in the sense expected. A U-tube method was used, and difficulties connected with the viscosity of the liquid militated against accurate numerical agreement. W. G. B.

436. *Mutual Action of Two Spheres falling in a Viscous Liquid.* **H. Faxén.** (Ark. f. Mat. Astron. och Fysik, Stockholm, 19. 13. [8 pp.], 1925. In German.)—It was hoped to be able to calculate the velocity of two spheres which touch one another and fall under the influence of gravity in a viscous liquid. This has not proved possible since the formula derived does not converge for this particular case. The mutual action of two spheres which do not touch is, however, defined with considerable accuracy. H. N. A.

437. *On the System of Vortices generated by a Circular Cylinder in Steady Motion through a Fluid.* **C. N. H. Lock.** (Phil. Mag. 50. pp. 1083–1089, Nov., 1925.)—In discussing the uniform motion of an infinite circular cylinder through an incompressible fluid of moderate viscosity, Kármán [see Abstract 294 (1912)] has suggested that the wake left behind by the cylinder takes the form of a double row of two-dimensional vortices. He has employed this conception of the flow pattern to calculate the resistance of the cylinder in terms of the period and velocity of these vortices. His values are in fair agreement with those of Relf, and the present paper contains an application of the Kármán theory to the further data of Relf and Simmons [Phil. Mag. 49. p. 509 (1925)], and especially examines its bearing on the sudden change in the resistance and frequency coefficients observed in the neighbourhood of $VL/\nu = 3 \times 10^5$. It is shown how it is possible that at high values of VL/ν the viscosity can modify the resistance coefficient without directly affecting the flow, except in the immediate neighbourhood of the body. The argument is confirmed by the case of the flat plate, in which the flow is entirely determined by the existence of sharp edges, and the resistance is independent of VL/ν except at very low values of this variable. H. H. Ho.

438. *Theory of Anisotropic Liquids.* **C. W. Oseen.** (Ark. f. Mat. Astron. och Fysik, Stockholm, 19. 9. [19 pp.], 1925. In German.)—In this paper a new theory of anisotropic liquids is developed for the case of axially symmetrical molecules, the treatment being based on that of previous papers [see Abstracts 1675 (1924) and 765 (1925)]. The new theory is essentially simpler than the older, particularly in the relationships between the coefficients for the case where all the molecules are of the same kind. All the terms of the older theory occur again in the newer with an additional one which was missed by the previous method of series development. The significance of this new term is that the theory now includes the distorted structures which play so large a part in Lehmann's investigations. In the author's theory of the focal conic sections of Friedel and Grandjean, a difficulty was encountered in that a particular term in the expression for the potential energy appeared to require that the areas to which the molecular rays are normals should have positive curvature, which is in contradiction with fact. This difficulty has been solved in that, without changing the equations for the orientation of the molecules, the objectionable term can be removed from the potential energy. A study has been made of the influence of a variable density on the orientation of the molecules, this being necessary because of the dependence of temperature and density on position. The formulæ derived show that a parallel orientation of the molecules for variable densities, apart from an exceptional case, is only possible when the density gradient is a vector with constant direction and when the molecular axes are parallel to their vector. The paper is mathematical throughout. H. H. Ho.

439. *Air-Flow Pattern in Wake of an Aerofoil of Finite Span.* **A. Fage and L. F. G. Simmons.** (Roy. Soc., Phil. Trans. 225. pp. 303–330, Dec. 7, 1925.)—Describes the results of measurements of wind speed and direction behind an aerofoil having a rectangular plan form, the ratio of span to chord being 6 : 1. Measurements were made in three planes respectively, 0·573, 2·0 and 13·0 chords behind the trailing edge, and in a plane 0·5 chord forward of the leading edge. The work provides an experimental verification of the theoretical relation given by Lanchester that the total strength of the vorticity leaving a semi-span of an aerofoil, as obtained by integration over a transverse plane close behind the aerofoil, is equal to the circulation around the median section; it also shows that the distribution of vorticity behind the aerofoil is closely connected with the distribution of lift along the span. The changes in the distribution of the vorticity in the wake, as the distance behind the trailing edge increases, are illustrated in diagrams which give contour lines of equal vorticity; immediately behind the aerofoil the vorticity is concentrated in a band which increases in depth and intensity towards the aerofoil tips; at 2 chords behind, the total strength of vorticity remains unchanged, but the weak region at the centre now disappears and the distribution at the tip becomes less intense and spreads over a larger area; at 13 chords behind it appears that the "rolling-up" of the vortex band is almost complete, and that only about 82 % of the total vortex strength leaving the aerofoil has been measured. The experiments also show that within the limits of experimental error the flow is irrotational at a distance of 0·57 chord in front of the aerofoil and also in the regions extending beyond the tips. The observations show that the longitudinal velocity is *approximately* uniform over each transverse plane behind the aerofoil. J. W. T. W.

440. *Determination of the Internal Friction of Sulphur Dioxide and of its Mixtures with Hydrogen.* **M. Trautz and W. Weizel.** (Ann. d. Physik, 78. 4. pp. 305–369, Dec., 1925.)—This very comprehensive paper deals with stream processes in capillary tubes and contains full details of experiments and apparatus, including critical discussions of error possibilities and their elimination. It is established that the Hagenbach correction of the kinetic energy is applicable; also that no tube effect has been observed while quite short tubes are applicable for experiments on kinetic energy. Corrections are included for deviations from the perfect gas. The viscosity of air has been determined for a large number of temperatures between 14° and 199° not hitherto investigated and the Sutherland formula thereby established, the Sutherland constant being found as a temperature function which reaches a maximum at ordinary temperatures. The temperature coefficient for the viscosity of sulphur dioxide is fairly constant between 14° and 199°, but does not satisfy the Sutherland formula, due doubtless to the deviation of sulphur dioxide

from the perfect gas. A maximum was observed with mixtures of sulphur dioxide and hydrogen, the curve for which tends to a level with temperature elevation. The increase of viscosity of mixtures with hydrogen is approximately proportional to the hydrogen molecular fraction up to the maximum. The temperature coefficients of the mixture is nearly that of sulphur dioxide up to the maximum and then falls gradually to that of hydrogen. A discussion is included as to the extent to which the viscosities of gases and gas mixtures can be regarded as corresponding characteristics. The concluding section contains the data curves, the requisite mathematical treatment, and a short bibliography of the subject.
H. H. Ho.

441. *On the Torsion of Hollow Oval Prisms.* **M. S. Ahmed.** (Phil. Mag. 50. pp. 1033–1048, Nov., 1925.)—The general solution of the problem of the torsion of oval tubes was given by Batho [see Abstract 92 (1917)], who obtained formulæ for strength and stiffness of infinitely thin prismatic tubes whatever their shape and whether the infinitely small thickness is uniform or not. Batho's formulæ are accurate for tubes of infinitesimal thickness, but may be slightly in error for the tubes of finite thickness mainly used in engineering structures. The object of this investigation is to establish formulæ for the torsional stiffness of uniform elliptic tubes likely to be made in practice, and to estimate the correction due to thickness necessary in applying Batho's formulæ. Exact formulæ are therefore derived for the stiffness of tubes bounded by similar and similarly situated ellipses and for tubes bounded by confocal ellipses. Approximate formulæ are then established for these two cases by Batho's method and error curves plotted for various values of B/A, where B is the area enclosed between the inner and outer boundaries and A is the over-all area. The results are used to estimate a mean value for the error in the case of uniform tubes such as are used in practice. The paper is entirely mathematical.
H. H. Ho.

442. *Secondary Effects of Shear on an Elastic Body.* **W. R. Dean.** (Phil. Mag. 50. pp. 1097–1114, Nov., 1925.)—The consistency of the results of Poynting's two series of experiments makes it almost certain that the real alteration in length due to twist is the lengthening found with wires with large loads. To account for this fact any general theory of elastic stability must demand extensions of Hooke's law, and such extensions have now been made from which equations are derived relating to the problem of the twisted wire. The first assumption was that in a distortion of any magnitude of an elastic body three linear elements are associated with each point of the body which are orthogonal both before and after strain, and these elements undergo stationary extensions. Comparison, however, of theoretical and experimental results revealed a serious divergence, but a modification of the initial assumption, *viz.*, to define stress as the action over an element of surface divided by the area of the surface after strain, produced better but still not satisfactory agreement. These two extensions of Hooke's law are the only satisfactory possibilities if additional elastic constants are not to be introduced. Should, however, the latter be invoked, the experimental data now available are inadequate for their determination. It was found experimentally that the secondary alterations depended on the direction of the twist, this being evidence of initial strain, and it appears impossible without further assumptions to get a lengthening of the right order of magnitude. Abstract 1797 (1925) should also be consulted. H. H. Ho.

443. *The Frequencies of Vibration of Flat Circular Plates fixed at the Circumference.* **H. Carrington.** (Phil. Mag. 50. pp. 1261–1264, Dec., 1925.)—The frequencies of the transverse symmetrical vibrations of a fixed circular plate depend on the solution of the equation

$$\mathrm{J}_{n+1}(z)/\mathrm{J}_n(z) + \mathrm{I}_{n+1}(z)/\mathrm{I}_n(z) = 0,$$

which can be solved by interpolation from tables of Bessel functions, but the evaluation of the roots becomes increasingly troublesome and has eventually to be effected by the ascending series for the functions. It is shown in the present mathematical paper that higher roots and approximate values for the lower ones can, however, more easily be obtained from the semi-convergent descending series for the same functions. H. H. Ho.

444. *Laplace's Equation and the Inversion of Coordinates.* **D. M. Wrinch.** (Phil. Mag. 50. pp. 1049–1058, Nov., 1925.)—A mathematical analysis in which it is demonstrated that if $V = f(\xi, \eta\zeta)$ is a solution of Laplace's equation for coordinates (x, y, z), then $V' = \frac{k'}{\gamma}f(\xi, \eta, \zeta) = \frac{r}{k}(\xi, \eta, \zeta)$ is a solution of Laplace's equation for the coordinates (x', y', z') inverse to (x, y, z). Special applications of the theorem to Neumann's transformation and Stokes' stream function are set forth. A. B. C. L.

445. *Irrotational Motion in Three Dimensions.* **D. Riabouchinsky.** (Comptes Rendus, 181. pp. 907–909, Dec. 7, 1925.)—The author obtains solutions for flow around a paraboloid of revolution and for flow through a circular aperture. W. G. B.

446. *The Meaning of the Separability of the Hamiltonian Differential Equation for the Periodicity of a Motion.* **E. Fues.** (Zeits. f. Physik, 34. 10. pp. 788–794, 1925.)—The unique separability of the Hamiltonian partial differential equation is stated in mathematical literature to be a criterion of conditional periodic motion. This is now shown by the author to be a sufficient although not a necessary condition for multiple periodicity. Other similar propositions are likewise proved to be consequences of certain symmetrical properties of the Hamiltonian function. The necessary and sufficient criterion of conditional periodic motion, apart from limiting cases, is then found to be the integrability of the equations which determine the impulse vector as a function of position. The paper is entirely mathematical. H. H. Ho.

447. *On Quantum Mechanics.* **M. Born** and **P. Jordan.** (Zeits. f. Physik, 34. 11–12. pp. 858–888, 1925.)—The recently published hypotheses of Heisenberg [Abstract 45 (1926)] are now developed into a systematic theory of quantum mechanics relating, however, to systems having one degree of freedom. The mathematics employed is the matrix calculus, and, after this has been briefly described, the mechanical equations of motion are derived from a variation principle. The proof is next established that, based on the Heisenberg quantum condition, the energy hypothesis and the Bohr frequency condition follow from the mechanical equations. In the case of the anharmonic oscillator the problems of the unique character of the solution and the meaning of the phases in the partial oscillations are discussed. The paper concludes with an attempt to derive the laws of the electromagnetic field on the new theory.

H. H. Ho.

448. *Physically Degenerate Systems and Quantum Dynamics.* **J. C. Slater.** (Phys. Rev. 26. pp. 419–430, Oct., 1925.)—The quantum theory can hardly continue to deal with periodic systems alone, and the natural approach to the study of non-periodic motion is through those systems, which are nearly but not quite periodic, and which are nearly but not quite quantised. It is suggested in this paper that systems interrupted before traversing a full period, or in an external field varying greatly in the time of one period, be called physically degenerate, and, in harmony with the ideas of Ehrenfest and Tolman, their quantisation becomes less and less complete as the degeneracy increases. In such cases the values of the related action variable and of the energy are grouped more or less closely about the mean values, were the systems completely quantised. Application is made to such problems as: quantisation in a small or rapidly changing magnetic field (including Glaser's results for the change of diamagnetic susceptibility of some gases with pressure, experiments by Breit and Ellett and by Wood and Ellett on depolarisation, and the experiment of Gerlach and Stern, in which atoms are projected into a strong field), absorption in the higher lines of the principal series of an alkali (including a discussion of quantisation in hyperbolic and parabolic units), and the continuous X-ray spectrum. This assumption demands the existence of quantum forces not previously considered in quantum theory whose action is to stabilise the stationary states, rapidly causing the action variables and energy to approach the proper values. These forces are opined to be responsible for the large change of energy and action variables during a quantum transition. The adiabatic theorem then appears in simple light: when the external parameters vary too rapidly, quantisation becomes poor, the quantum forces become strong and put the atom into a quantised state again. In any atom but hydrogen quantum forces act continuously, opposing interchange of energy and momentum between electrons and keeping each electron quantised. These forces are destined to be important in the quantum dynamics of atomic constitution in connection with the dynamics of oscillators.

H. H. Ho.

449. *The Metric of the Four-dimensional Space-time Continuum.* **D. Meksyn.** (Phil. Mag. 50. pp. 1227–1244, Dec., 1925.)—The notion of the constancy of the velocity of light-propagation, the Lorentz transformations and the mechanics of a material point are derivable as geometrical laws based on the conception of a four-dimensional space-time continuum. The idea of the relativity of time and space is then not only superfluous, but in contradiction to the assumption that the continuum is a metrical one in the Riemannian sense. The conception of a metric of a space as such is meaningless if applied to non-Euclidean space, so that such a space cannot be used as a general system of reference for physical laws.

J. S. G. T.

450. *Stokes-Planck Theory and Michelson-Morley Experiment.* **W. F. G. Swann.** (Nature, 116. p. 785, Nov. 28, 1925.)—The Planck generalisation introduced the idea of a variable ether density, and by making the ratio of the density at a selected spherical surface to that at infinity sufficiently large it was possible to make the tangential velocity as small as desired. But from the expression for the velocity potential given in Note 67 of Lorentz's "Theory of Electrons" it is easily seen to follow that, where R is the earth's radius, W_0 the relative velocity parallel to the axis of z at infinity, with the origin at the centre of the sphere, r the radius, and z the distance from the origin parallel to W_0, then if V_R and V_{R+h} are the horizontal ether drifts for $z = 0$ at $r = R$ and $r = R + h$ respectively, where h is a relatively small increment in r, $(V_{R+h} - V_R)/V_R = h/R$. Hence, if $h = 1 \cdot 7$ km., and R is the radius of the earth (6400 km.), it is obviously impossible to have the change in velocity $V_{R+h} - V_R$, which Miller concludes to be 10 km. per sec., comparable even with the quantity V_R which the object of the large density ratio is to render negligible. G. W. DE T.

451. *Arrangement of Micro-crystals in Aluminium and Copper Wires.* **T. Fujiwara.** (Kyoto Coll. Sci., Mem. 8. 5. pp. 339–355, Aug., 1925. In English.)—In the present experiment the arrangement of the micro-crystals in the drawn wires of Al and Cu was examined by means of X-ray patterns. It was ascertained that the X-ray patterns were explainable by the consideration that the trigonal axes of the crystals are arranged nearly parallel to the axis of the wire, leaving the orientation in other respects rather at random. In the case of Al wire more detailed examination was made, and it was shown that the trigonal axes of the crystals were not arranged exactly parallel to the axis of the wire, and that the crystals whose trigonal axes are inclined at about 7° to the axis of the wire are the most predominant. AUTHOR.

452. *Theoretical Calculations of the Physical Properties of Certain Crystals.* **J. E. Lennard-Jones** (formerly **J. E. Jones**) and **P. A. Taylor.** (Roy. Soc., Proc. 109. pp. 476–508, Nov. 2, 1925.)—The methods previously described [Abstract 1812 (1925)] are elaborated and extended, the repulsive fields of a number of ions being determined and used to calculate a number of crystal properties, including compressibility and elasticity, which are compared with the available experimental data. An attempt is made, with the help of Wasastjerna's results on ionic refractivities [Abstract 2053 (1922)], to determine these characteristic force constants. It is found that the repulsive forces of the neon-like ions in crystals may be represented by an inverse 11th-power law, each ion having its appropriate force constant, whilst the repulsive forces of the argon-like ions may be represented by an inverse 9th-power law. These results are in close accord with the power laws obtained by Born and Landé [Abstract 528 (1919)] in their simple deduction of repulsive fields from crystal compressibilities. With the object of furnishing a more accurate representation of ionic fields than has previously been given, a table showing the forces between various ions is drawn up, this being intended to replace to some extent the characteristic sizes of ions derived by various authors. The forces thus determined supply satisfactory interpretations of the interatomic distances in crystals, and lead to values of crystal energies and compressibilities which agree well with observed values; they are used also to predict the interatomic distances of crystals not yet measured, such as those of calcium chloride, and to calculate other properties of crystals. The properties of crystalline argon are considered, and the conclusion is drawn that, whereas an argon-like core appears to repel according to an inverse 9th-power at small distances, repulsion according to the inverse 15th-power is more appropriate at large distances. T. H. P.

453. *Bending of Crystals.* **C. H. Bosanquet.** (Phys. Soc., Proc. 38. pp. 88–91, Dec., 1925.)—X-ray observations by the author on slips of rock-salt, which have been plastically bent when immersed in strong brine at 50°–70°, indicate that the crystal breaks down into a number of small undistorted crystals, each of which makes a small angle with its neighbours; the prismatic spaces between the crystals are presumably filled with NaCl in an amorphous state. These conclusions are in general agreement with the work of Joffé. When the crystal is bent and a minute fissure forms, it will be filled immediately with the hot brine, which is saturated with respect to plane surfaces and supersaturated for concave surfaces, so that solid will be deposited in the crack at the point of maximum stress, the result being that the tensile strength is increased enormously. H. N. A.

454. *The Structure of α and β Quartz.* **W. Bragg and R. E. Gibbs.** (Roy. Soc., Proc. 109. pp. 405–427, Nov. 2, 1925.)—It has previously been shown that ordinary or α quartz belongs to space group D_3^4 or D_3^6 according to the rotatory sense of the lattice. Four parameters remained to be determined, the distance of the silicons from the screw axis of the unit cell and three others defining the spatial relations of the oxygens to the silicons. It is not possible to determine the four unknowns by means of the intensities of the reflections of X-rays alone, though they can be used as a useful check on the method used in the present paper, which consists in considering the β modification of quartz, which is formed when ordinary or α quartz is heated to 575° C., and which has a higher degree of symmetry than the latter, being a hexagonal crystal while α quartz is trigonal. At the same time there is evidence that the actual movement of the atoms when the change takes place is a small one, so that it is possible to deduce the structure of the β quartz from X-ray intensity measurements, since owing to the symmetry conditions only one parameter has to be determined, and then to consider what small relative shift of the atoms will produce a structure having the properties of α quartz. The structures deduced fit in quite well with the atomic diameters previously obtained for silicon and oxygen, and it is possible to explain by means of them the somewhat complicated twinning relations which have been observed for this substance and the piezo-electrical and pyro-electrical properties. H. N. A.

455. *Influence of Pores in the Crystal Lattice on Molecular Mobility and Strength.* **A. Smekal.** (Phys. Zeits. 26. pp. 707–712; Disc., 712, Nov. 15, 1925. Paper read before the Deut. Physikertag., Danzig, Sept., 1925.)—Examines the hypothesis that in such crystals as rock-salt the atoms in the interior of the perfect lattice remain fixed with regard to one another, and that when movements take place in the ions in actual crystals this is over the surfaces of sub-microscopic pores, so that an ideal or perfect crystal with no pores would not conduct electricity. Processes of diffusion in crystals would also depend upon these pores, and it is shown that a number of recent observations can be explained by means of them. By considering the colouring effects in crystals it is possible to show that the total volume of the pores is, in general, smaller than the degree of accuracy of the best density determinations. The effect of such pores upon the strength of the material is considered; in a monocrystal their presence must diminish the tensile strength, and also the shearing strength, below that corresponding to the molecular chemical strength of the component particles, and this may account for the difference between the "technical" and the "molecular" strengths of such substances. It is suggested that the "strengthening" of a crystal, which takes place with shearing, may be explained by a closing of the pores. The behaviour of mercury when condensed from vapour to solid on a cooled surface is considered, as giving an indication of the way in which pores are formed. H. N. A.

456. *Fusion of Crystalline Solids.* **K. R. Ramanathan.** (Indian Assoc. for Cultivation of Science, Proc. 9. 3. pp. 179–186, 1925.)—The definite melting-points and the absence of superheating of crystals are due to the fact that the superficial molecules are less closely bound than those in the interior. The forces between atoms and molecules are of two kinds, one uniform all round the atom or molecule, the other specially concentrated in definite directions, and melting takes place when the directional bonds became loosened owing to thermal vibrations. Some bonds may be loosened throughout the crystal at temperatures far below the melting-point, producing change of crystal form; melting does not take place until the strongest bonds are broken. In the case of a number of aromatic compounds there is approximately a definite molecular heat of fusion, corresponding to each benzene ring; this is presumably connected with the similarity of binding between molecule and molecule. X-ray evidence regarding the structures of naphthalene and anthracene confirms this. H. N. A.

457. *Lattice Types and an Isotropic Ion capable of Polarisation.* **F. Hund.** (Zeits. f. Physik, 34. 11–12. pp. 833–857, 1925.)—Assuming that a crystal lattice consists of ions with given charges, capacity for polarisation and repelling one another according to a law $F = b/r^n$, which differs from Coulomb's law when they are close together, it is possible to make deductions as to the nature of the resulting lattice type. When the capacity for polarisation is small, so-called coordination lattices result, in which each ion is regularly surrounded by neighbours, and similar ions have the same surroundings; the various types of coordination lattice can be explained as being due to differences in the values of n. When the capacity for polarisation is large, molecular lattices may result, as well as a type to which so far little attention has been paid, *viz.*, the lamellar lattice, *Schichtgitter.* The results of the theory are shown to agree qualitatively with those of observation. The paper develops the ideas contained in a previous paper by the author [Abstract 227 (1926)], and the subject is treated in part mathematically, the energy of the wurtzite lattice, the non-Coulomb portion of the energy of the rutite lattice and the energy of the cadmium iodide lattice being calculated. H. N. A.

458. *Structure of Barium Sulphate.* **R. W. James** and **W. A. Wood.** (Manchester Phil. Soc., Mem. 69. 5. pp. 39–51, 1924–1925.)—Barium sulphate belongs to an isomorphous series, comprising sulphates, selenates and chromates of strontium and barium, sulphate of lead, the perchlorates of K, Rb, Cs and NH_4 and the perchlorate of thallium, all of the type XRO_4, where X is a kation and RO_4^- an anion. $BaSO_4$ belongs to the space group V_h^{16}, and a figure is given showing the symmetry elements of the group necessary for understanding the structure. In the expression for the amplitude factor, A, of the diffracted rays there is a factor, F, for each of the atoms in the unit of structure, where $F = Z\phi(\theta)$ and $\phi(\theta)$ is a function of θ, which decreases as θ increases, but is different for each kind of atom; Z is the number of electrons contained in the atom or ion. It is probable that, for glancing angles greater than about 20°, the oxygen atoms have very little effect at all, and the intensities of the spectra are determined by the barium atoms. Actual determination of positions from the intensities is not possible, but assuming that the SO_4 group is probably a tetrahedral arrangement of O ions about a central S, the distance S to O being about 1·5 Å., as A. J. Bradley has found in the case of $LiKSO_4$, and taking into account the fact that the *b* spacings of $BaSO_4$, $SrSO_4$ and $PbSO_4$ seem to be determined by the packing of the SO_4 groups, a structure is deduced which is represented diagrammatically in a figure, the coordinates of the Ba and S atoms being given in a table. [See following abstract.] H. N. A.

459. *Crystal Structure of Barytes, Celestine and Anglesite.* **R. W. James** and **W. A. Wood.** (Roy. Soc., Proc. 109. pp. 598–620, Dec. 1, 1925.)—The authors have published a preliminary note on barytes, in which the positions of the barium atoms were determined with some degree of accuracy [see preceding abstract]. A more complete study of all three crystals leaves the positions of the metal and sulphur atoms unchanged, but has modified those of the oxygen atoms considerably. In carrying out the calculations the authors have assumed Hartree's curve for Ba and Sr, while that for Pb has been estimated from the author's figures for thallium; the metal in each case has been supposed ionised, and the same is true of the oxygen and sulphur, O^{-2} and S^{+6} respectively. The structures of the three substances are very similar, being based on a simple orthorhombic lattice, with four molecules to the unit cell, space group V_h^{16}. It is found that the observed intensity is in all cases lower than, although of the same order of magnitude as, the calculated. Diagrams are given showing the positions of the atoms in relation to different planes and a drawing of a model showing the relation between the Ba and SO_4 ions in $BaSO_4$. The similarity of structure in the isomorphous crystals is determined by the tetrahedral arrangement of O ions in the group RO_4; when R is larger the whole structure can be expected to expand, with little alteration in the axial ratio. No large change is to be expected when the size of the metal ion is altered. Some observations on $KMnO_4$ and $KClO_4$ confirm these deductions. H. N. A.

460. *The Crystalline Structure of Hexachlorobenzene and Hexabromobenzene.* **W. G. Plummer.** (Phil. Mag. 50. pp. 1214–1220, Dec., 1925.)—It is difficult to grow large crystals of either of these substances, and the powder method was employed, the chlorine compound being fully investigated; the bromine compound is isomorphous with it and only a few spacings have been measured for hexabromobenzene, which, however, suffice to prove that its structure is similar to that of hexachlorobenzene. A small perfect crystal of the latter has been grown, with which spectrometer measurements and rotated crystal photographs have been obtained, which confirm the suggested structure. The space group for both substances is C_{2h}^4 two molecules per unit cell; $a = 8 \cdot 10$ Å., $b = 3 \cdot 86$ Å., $c = 16 \cdot 68$ A., $\beta = 116° 52'$ for the chlorine compound. The molecules are of two types, A and B, a B molecule being obtained by gliding reflection of an A molecule in the (010) plane or a rotation about the *b* axis. It is probable that the molecules are centro-symmetrical. Diagrams are given representing a model in which the measurements of the "puckered" benzene ring of W. Bragg are used and his chlorine diameter. A good "fit" is obtained, and the cleavages of the crystal are accounted for. H. N. A.

461. *Configuration of Geometrically Isomeric Carbon Compounds.* **A. Langseth.** (Zeits. phys. Chem. 118. pp. 49–64, Oct. 25, 1925.)—Gives a series of tables in which the melting-points, boiling-points, solubilities, densities, dissociation constants, refractive indices and heats of combustion of a number of cis- and trans-derivatives of ethylene are compared with those of the corresponding ortho- and para-derivatives of benzene. It appears that the trans-compounds have in general higher melting-points than the cis, agreeing with Michael's assumption; there is no corresponding rule for the boiling-points; v. Auwers' rule that the cis-compounds have greater density and higher refractive index but smaller molecular refractive power than the corresponding transforms is confirmed. Similar rules appear to hold when the ortho-benzene derivatives are compared with the para. H. N. A.

462. *Researches on the Isomorphism of the Molybdates of the Rare Earths with those of Calcium, Strontium, Barium and Lead.* **F. Zambonini** and **R. G. Levi.** (Accad. Lincei, Atti, 2. pp. 149–152, Sept., and pp. 225–230, Oct., 1925.)—Reference to previous investigations is followed by five pages of tables, giving in detail the results of the authors' researches. These should be consulted, as they cannot be summarised. The röntgenographic investigations were carried out by the method of powders of Debye and Scherrer. A tube of the Siegbahn-Hadding type was used with a copper anti-kathode, and Scherrer's photographic camera, 57 mm. in diameter, which gives the values directly in degrees from the millimetre readings of the photograms. Corrections for the diameter of the preparation, 1·5 mm., are not introduced, as an exact calculation of the röntgenograms does not come within the scope of these preliminary researches. [See Abstract 294 (1925).] E. F.

463. *The Theory of the Atom.* **F. Dacos.** (Assoc. Ing. Él. Liége, Bull. 3. pp. 197–225, July–Aug., and pp. 264–283, Sept.–Oct., 1925.)—Continues the paper previously noticed [see Abstract 2017 (1925)]; explains mathematically the theory of quanta, and describes the Bohr atom, dealing with both circular and elliptical orbits, and introducing the relativity effects. In the concluding section the relation between the theory and the spectra of the elements is dealt with, including X-ray spectra. H. N. A.

464. *Nuclear Numbers.* **D. de Barros.** (Comptes Rendus, 181. pp. 719–722, Nov. 16, 1925.)—The nuclear number is defined as the nearest integer to $\frac{1}{2}(M - N)$, where M is the atomic weight and N the atomic number. The periodic table is written out in the order of atomic numbers, starting with helium, and passing horizontally to the seventeenth element, chlorine. Argon comes below helium, and again a similar horizontal line is built up. In this way the table is written out in sixteen columns, each with five members. In some cases elements are grouped together, in one compartment, *i.e.* Fe, Co and Ni. The nuclear number is now calculated for each element and a corresponding table of numbers written out. These numbers now closely correspond to the list given by Mayer dealing with the groupings of floating magnets. Some other properties of the nuclear number are considered. It is shown, for instance, how a knowledge of the nuclear numbers of adjacent elements may be used to calculate unknown atomic weights. A. A. D.

465. *Prrturbations in Molecular Models.* **Lucy Mensing.** (Zeits. f. Physik, 34. 8. pp. 602–610, 1925.)—The author studies the perturbations in molecules consisting of two atoms, in which the electrons of one atom do not at the same time revolve about the nucleus of the other. The impulse of rotation in general is in the direction of the line joining the two atoms. In the case of one of the plane models it is perpendicular to the connecting line. This model is unstable for molecules containing two atoms of the same kind, but may be stable in certain cases when the two atoms are different. For molecules with two different atoms there is also an unstable model, with the two single impulses perpendicular to the connecting line and to one another. There is no quantum solution corresponding to an inclined impulse. H. N. A.

466. *Numerical Relations between Atomic Masses and Atomic Structure.* **H. Stintzing.** (Zeits. f. Physik, 34. 9. pp. 656–695, 1925.)—The atomic numbers, and also the atomic masses, in the vertical columns of the periodic system form so-called tetrahedron series. It is possible to build up geometrical figures based on the tetrahedron which, assuming protons to be placed at the corners and in some cases at the centre and on the edges, give masses equal to those of the various isotopes. For example, a tetrahedron with protons at the corners has mass 4 and corresponds to helium; a fifth proton at the centre of the tetrahedron would give mass 5, and would correspond to a hypothetical isotope of helium. A tetrahedron with two extra protons at the centres of opposite edges (at right angles to one another) of the tetrahedron would have mass 6, and would correspond to one of the isotopes of lithium, while a seventh proton at the centre of the same arrangement would give a nucleus with the mass of the other lithium isotope. The system is worked out in detail to account for isotopes of a number of elements. The structure is supposed to be stabilised by the nuclear electrons moving in orbits, as in Bohr's theory of the extra-nuclear electrons. H. N. A.

467. *Relativistic Keplerian Motion.* **G. v. Gleich.** (Zeits. f. Physik, 35. 1. pp. 7–21, 1925.)—The significance of the term "relativistic" needs precise definition. Whittaker's formulæ ("Analytical Dynamics of Points and Rigid Bodies") indicate that neither the special nor general theory of relativity is essential to the discussion of astronomical or atomic dynamics, which can be more satisfactorily treated by the aid of classical dynamics together with the postulate of the variability of mass, upon which is based a "kinetic theory of mass." It is pointed out that

whereas Einstein's theory of the advance of the perihelion of mercury gives a value of this advance equal to 43″ per century, the most recent discussion of the observations indicates that the observational value is at most from 28″ to 39″ per century. Whittaker's method affords a value ranging from 22″ to 36″ according to the assumptions made.
J. S. G. T.

468. *A Relativistic Definition of Simultaneity.* **Lémeray.** (Comptes Rendus, 181. pp. 770–772, Nov. 16, 1925.)—The author's mode of deduction of a relativistic definition of simultaneity is compared with the mode of deduction employed by Metz [Comptes Rendus, 180. p. 1827, June 15, 1925].
J. S. G. T.

469. *Fizeau's Experiment and the Principle of Relativity.* **W. Rivier.** (Arch. des Sciences, 7. pp. 368–374, Nov.–Dec., 1925.)—The relation of Einstein's formula for the addition of velocities to Fresnel's formula for the partial entrainment of ether in a refracting medium is briefly discussed. [See Abstract 797 (1925).]
J. S. G. T.

470. *An Alternative Treatment of Fermat's Principle for a Stationary Gravitational Field.* **J. L. Synge.** (Phil. Mag. 50. pp. 913–916, Nov., 1925.)—This paper contains a treatment of Fermat's principle which is offered as an alternative to the proofs of Levi-Civita [see Abstract 744 (1919)] and of Weyl ("Raum, Zeit, Materie," 4th ed., p. 221). The proof does not require the use of the calculus of variations except in the theorem that if F be a function of coordinates $x_1, \ldots, x_N$ and their derivatives $\dot{x}_1, \ldots, \dot{x}_N$ with respect to a parameter λ, then the variational equation $\delta\int F d\lambda = 0$, the end points and the terminal values of λ being fixed, is equivalent to the Lagrangian equations

$$\frac{d}{d\lambda}\frac{\partial F}{\partial \dot{x}_r} - \frac{\partial F}{\partial x_r} = 0 \quad (r = 1, \ldots, N)$$

H. H. Ho.

METEOROLOGY AND GEO-PHYSICS.

471. *Weather Cycles. I. Synoptic Analysis by Clayton's Method.* **L. Danilow.** (Meteorolog. Zeits. 42. pp. 417–422, Nov., 1925.)—The author has extended the method introduced by Clayton [Abstract 1457 (1907)] for long-range forecasting. Observations of pressure for four periods between 1911 and 1915 were used for 100 to 120 stations between Greenland and latitude 40° N. The calculations were set out graphically and by synoptic charts to give: (1) 2½-day pressure means, (2) difference between observed pressure and 2½-day means, (3) 5-day pressure means, (4) difference between 2½- and 5-day means, and (5) daily changes of 5-day means. The several features of these different charts are explained. The main centres of pressure and attendant secondaries are obtained by comparison of the daily chart with the 5-day mean chart. Knowing from these charts of mean values the average velocity of propagation of different groups of disturbances, one can then get the individual features of existing centres and draw conclusions for subsequent changes. Finally, from a study of 5-day barometer curves and charts of isallobars it is often possible to forecast changes up to one week ahead.
R. S. R.

472. *Origin of Tropical Cyclones.* **A. Reich.** (Meteorolog. Zeits. 42. pp. 428–430, Nov., 1925.)—The author refers to earlier work on the electrification of clouds and the intense electric forces existing in the atmosphere when cumulus clouds are present. He considers that vortices may be produced in the atmosphere by the conversion of this store of electric energy in a potential form into kinetic energy of the air. Similar conditions can explain the formation and growth of whirlwinds, waterspouts, tornadoes and hailstorms. Experiments are described using a powerful electrical influence machine by which a miniature waterspout is produced. The frequency of tropical cyclones agrees as to time of year with the frequency of magnetic storms at Samoa as observed by Angenheister. R. S. R.

473. *Condensation of Water-Vapour as a Problem of Meteorological Optics.* **W. Milch.** (Meteorolog. Zeits. 42. pp. 422–428, Nov., 1925.)—The results obtained at Taunus Observatory for the turbulence factor for total solar radiation, and its connection with cloud amount and precipitation, are compared with similar figures for Davos. The equation connecting turbulence factor and cloud amount is very similar for the two places. Six types are considered: (1) Convection, (2) approaching depression, (3) approaching anticyclone, (4) boundary disturbances, (5) inversion layers, and (6) Föhn type, and the variation of the turbulence factor through the day given for each. Changes are supposed due to changes in the condensation nuclei and in the water-vapour content, and results from both observatories confirm the idea. Local effects due to smoke alter the results somewhat. Forecasting the mean cloud amount and rainfall by the relation is possible. A relation is given connecting the variation of the polarisation of the sky with the number and size of the large particles of moisture, and the capacity of these particles to reflect the light diffusely. [See also Abstract 2210 (1924).] R. S. R.

474. *Fluid Motions produced by Differences of Temperature and Humidity.* **H. Jeffreys.** (Roy. Meteorolog. Soc., J. 51. pp. 347–356; Disc., 356, Oct., 1925.)

475. *Measurements of the Amount of Ozone in the Upper Atmosphere.* **D. N. Harrison** and **G. M. B. Dobson.** (Roy. Meteorolog. Soc., J. 51. pp. 363–367; Disc., 367–369, Oct., 1925.)—Preliminary note on measurements started to investigate the relation between quantity of ozone and pressure distribution. Measurements extending over a year are necessary to establish full details, therefore a complete account is reserved for a later paper. The method used was that of Fabry and Buisson, omitting the double spectrograph. A home-made Féry spectrograph was built, giving a dispersion of 13 Å. per mm. at 3000 Å. An optical wedge was fixed immediately in front of the plate so that the spectral lines decrease in intensity along their length, and thus serves as a measure of their brightness. A filter of bromine vapour and chlorine limits the incoming light to wave-lengths shorter than about 3300 Å. and serves the purpose of the second spectrograph and filter of Fabry and Buisson. Figures show the results thus far obtained. It is hoped that further measurements will test the suggestion that variations in ozone may, by changing the equilibrium temperature, cause variations in the pressure at lower levels. In the *Discussion*, the author said that the original object of the work was to try to find something further about the conditions in the stratosphere in cyclonic and anticyclonic conditions. E. F.

476. *On Periodicity.* **G. T. Walker.** (Roy. Meteorolog. Soc., J. 51. pp. 337–345; Disc., 345–346, Oct., 1925.)—Various changes in principle which have been suggested since Schuster introduced the periodogram are examined to test the reality of the periods indicated by the analysis. The criteria adopted are applied to analyses of periods by Brunt [Abstract 305 (1920)] and Baur. The proposals for shortening the labour of finding periodicities of Whittaker by plotting oscillations, and Brooks by the difference periodogram, are recommended, but not Whittaker and Robinson's proposal in their "Calculus of Observations," nor Craig's method of correlating series. Turner's method of handling discontinuities in meteorological phenomena is considered, and finally Clough's method of treatment of periods of variable length is discussed. R. S. R.

477. *Meteorological Periodicities of the Order of a Few Years, and their Requisitely Local Investigation; with Especial Reference to the Term 5·1 Years, in Parts of Britain.* **J. Baxendell.** (Roy. Meteorolog. Soc., J. 51. pp. 371–394; Disc., 394–395, Oct., 1925.)—The author has established the 5·1 year period from examination of the rainfall records at Southport and Bolton, the duration of N. and N.E. winds at Southport, and of N., N.E. and E. winds at Greenwich, the mean air-pressure over London, the exceptionally violent gales on the Lancashire and Cheshire coasts, and the frequency of great frost winters in London. The results obtained for rainfall at Southport were tested for other parts of the country, but the period had its maximum effect in the coastal and northern parts of Lancashire, and perhaps much of Cumberland. The author found also that the period was not equally in evidence at all times. An addendum by **E. G. Bilham** gives the corrections to the amplitude of a 5-yearly oscillation computed from smoothed data. **L. C. W. Bonacina** drew attention to the influence of a weak winter "monsoon" effect influencing the wind frequencies at Southport. An extensive bibliography is included in the paper. R. S. R.

478. *Gustiness of Wind in Particular Cases.* **A. H. R. Goldie.** (Roy. Meteorolog. Soc., J. 51. pp. 357–362; Disc., 362, Oct., 1925.)—Reference is made to the difference between the gustiness in equatorial and polar air currents. The temperature distribution in the former is usually very steady, and the eddies contained in it are generated as the counterpart of the waves produced by it on the surface of the ocean. The polar current would mostly be less stable in the vertical, owing to the greater changes of temperature experienced by it, and possibly also to having passed partly over land, while the eddies in it would not be of one uniform type as before. Observations were made at Falmouth on the gustiness of the wind, and the period of the waves, and the mathematical theory of the waves produced in the air and in the water by a steady wind blowing over a great stretch of ocean was developed. Rules are given which form a guide to the source of the air arriving at a station, these following from a study of the anemograms obtained there. Finally, the effect of waves on a surface of discontinuity in changing the magnitude of the gusts is explained, and examples are quoted where this effect is illustrated. R. S. R.

479. *On Tidal Features of Local Coastal Origin and Sea-seiches.* **J. Proudman.** (Roy. Astron. Soc., M.N. Geophys. Suppt. 1. pp. 247–270, Dec., 1925.)—The paper forms an extension of one published by the author in 1914 (London Math. Soc. Proc.) on the diffraction of tidal waves. The general equations are deduced for a flat sea, neglecting the direct effect of astronomical disturbing forces and of frictional forces, and the position of the co-tidal and co-range lines are determined. The effects produced in these equations by introducing into the area considered (1) a small circular island, (2) a small elliptic island, (3) a semi-elliptic cape, (4) a rectangular bay, (5) a passage between two seas for (*a*) no primary elevation at the centre of the passage, and (*b*) no primary current on the coast, (6) a long narrow channel, and (7) a narrow gulf, are examined. By sea-seiches the author means the oscillations of fairly definite period but of irregular amplitude and phase, which are frequently observed on the sea coast, and whose physical nature appears to be the same as that of " vibrations " in lakes. The cases considered are (1) a discontinuity of depth parallel to the shore, and (2) an elongated rectangular gulf. In each case is obtained the amplitude of the oscillations generated by a periodic disturbance out at sea, obtaining in particular the period for maximum resonance, and also the rate of decay of the oscillations when the disturbance at sea ceases. Use is made of certain conformal transformations, and some of these are derived in an appendix. R. S. R.

480. *Variation of the Velocity in Tidal Streams with Depth.* **J. H. Powell.** (Roy. Astron. Soc., M.N. Geophys. Suppt. 1. pp. 270–280, Dec., 1925.)—An accurate series of measurements was made of the velocity of the tidal stream at different depths in (*a*) the sound of Jura and (*b*) the Solent, selecting sites where the depth was uniform and small in comparison with the breadth of the Channel, and the tidal stream fairly steady over a considerable area. Calibrated tide meters were used two at a time, one as near the surface as possible, and the other at one of four depths selected according to the depth of the site. Corrections to the depth being applied for the rise and fall of the tide, very consistent results are obtained. The author found that (1) the decrease of the velocity of the tidal stream is proportional to the square of the depth where the total depth is not excessive; (2) the variation in velocity is more marked at low than high speeds; (3) the conditions of variation with depth are constant for any particular locality, but they differ considerably in different places with the configuration of the Channel. A rough estimate of the value of the coefficient of eddy viscosity has been made, and it is found to have 10^5 times the value for the normal viscosity under conditions of steady flow. R. S. R.

481. *Oceanic Tides as Modified by a Yielding Earth.* **R. O. Street.** (Roy. Astron. Soc., M.N. Geophys. Suppt. 1. pp. 292–306, Dec., 1925.)—A summary is given of earlier work by several authors on oceanic tides, obtained by analysis of tidal observations and the influence of a yielding earth on these values. The assumption is made that for the actual earth the free oscillations have periods all of which are short compared with the periods of the chief tide-producing astronomical forces, and the dynamical theory of tides is developed using this simplification. The general method employed is similar to Hough's treatment for ocean tides on a rigid earth, the tidal elevations of the two surfaces being expanded in a series of spherical harmonics. Further, the earth is assumed to be an incompressible sphere of uniform density and rigidity. The main results obtained are: (A) In the absence of external disturbing forces, the ellipticities of the surface of the sea, and of the submerged earth due to centrifugal stress, are about 1/320 and 1/470 respectively. If the earth were perfectly rigid the ellipticity of the ocean surface would be about 1/520. (B) The relative oceanic tide calculated on the statical hypothesis is slightly greater than half the "equilibrium tide" due to the same disturbing forces on an ocean covering a rigid earth. The earth-tide is somewhat greater than this "equilibrium tide." The relative oceanic tide calculated on this theory differs by about 4 % from that calculated from Kelvin's formula, in which the interaction between the earth and the water is neglected. On the other hand, about one-seventh of the earth-tide is due to the direct action of the water. (C) The general effect of the yielding of the earth is to reduce all the harmonic constituents of the relative oceanic tide. Compared with the tide in an ocean covering a rigid earth the principal constituent is reduced to about half its value; for the higher harmonic constituents the reduction is slightly less. The effect of the yielding is thus about the same as on the statical theory. Only a very small part of the earth-tide can be attributed to the direct action of the water. (D) For an ocean of a uniform depth of 7260 ft. covering the elastic earth, the slowest symmetrical free oscillation has a period of about 18½ hours. This is about ten minutes longer than if the earth were perfectly rigid. R. S. R.

482. *On the Problem of the Tides. A Generalisation of the Problem of the Lissajou Curves.* **G. Tiercy.** (Arch. des Sciences, 7. pp. 299–307, Sept.–Oct., 1925.)—The study of the tides becomes that of the small oscillations of a mechanical system of a very large number of particles about its position of stable equilibrium under the influence of periodic perturbating forces. The n equations which can then be derived for the particular small oscillations are discussed in this paper, and a solution derived which is interpreted geometrically. The general solution is then found to be bound up with that of the Lissajou curves. A final section is devoted to the influence of friction upon the tides, where again the generalised problem becomes that of the Lissajou curves, friction producing merely a slight diminution of amplitude. The paper is mathematical throughout. H. H. Ho.

483. *Surface Waves of Earthquakes.* **H. Jeffreys.** (Roy. Astron. Soc., M.N. Geophys. Suppt. 1. pp. 282–292, Dec., 1925.)—The paper forms a continuation and extension of Love's view that the oscillatory character of the portion of a seismic disturbance, arriving later than the P and S phases and their reflections, is due to dispersion, and this is due to a dependence of the wave-length on the period. The group-velocities of Love waves—*i.e.* waves of a purely distortionless type, involving horizontal movement at right angles to the direction of propagation, but no vertical movement, and becoming insignificant at great depths—are worked out for a surface composed of materials similar in properties to those of the earth's crust. The results indicate a period for which the group velocity is a minimum, this minimum being slightly less than the velocity of pure distortionless waves in the upper crust. Its value and the observed period of waves of a higher velocity indicate that the thickness of the upper layer is about 15 km., agreeing with that found from the theory of the cooling of the earth. Rayleigh waves also possess a minimum group velocity, which must be less than 2·9 km./sec. The effects of dispersion on surface waves are next examined. The simplest type of dispersion indicates that the periods with the greatest amplitude should be the same at all distances from the epicentre, but actually there is a systematic, irregular increase. Allowance for the existence of a minimum group-velocity introduces a variation of the predominant period with distance, but in a direction opposite to that observed. The author suggests that variation in the thickness of the upper layer transforms the surface waves partially into bodily waves and into surface waves of other types, and that this effect is greater the longer the period. The observed increase in the relative importance of the longer periods with distance may thus be explained. R. S. R.

ASTRO-PHYSICS.

484. *The Pyrheliometer of the Physical Institute, Upsala University.* **E. Bäcklin.** (Ark. f. Mat. Astron. och Fysik, Stockholm, 19. 10. [14 pp.], and 19. 18 [8 pp.], 1925. In German.)—This instrument, an Ångström compensation pyrheliometer No. 70, which was constructed in 1894 by Messrs. Rose in Upsala, proved so reliable and simple in use for observation of solar radiation that the International Union for Cooperation in Solar Research decided at Oxford in 1905 that it should be accepted as the standard instrument. It has been fully described in several publications. It has now been carefully tested and found to have remained unchanged during the nineteen years from 1905 to 1924, in which other instruments have been compared with it. M. A. E.

485. *Effective Wave-lengths of Stars from Declination* 80 *to the North Pole.* **F. Dyson** and **E. Martin.** (Roy. Astron. Soc., M.N. 86. pp. 28–32, Nov., 1925.)—The methods used are similar to those described in a previous paper [Abstract 2228 (1924)]. A table is given of the number of stars in the region considered for each half-magnitude having also effective wave-lengths within ranges of 50 Å.U. from $\lambda 4150$ to $\lambda 4500$ as well as above and below these wave-lengths. Within the limits of magnitude considered there is no evidence of change in the percentage of stars of different effective wave-lengths with different magnitude. Translating these figures into terms of spectral types according to the Draper catalogue shows that the effective wave-length changes rapidly from BO to AO and from GO to M, but slowly from AO to GO. It seems that the redder stars of any spectral class are of greater luminosity than the bluer stars. A. Wh.

486. *Equilibrium of a Stellar Cluster.* **C. Parvulesco.** (Comptes Rendus, 181. pp. 849–851, Nov. 30, 1925.)—The cluster is supposed to be free from rotational movement as a whole. It will then have a spherical distribution, and by the equi-partition of energy the larger masses will tend to move in orbits less removed from the centre than the lighter components. In a cluster of uniform density, the number of collisions in circular orbits will exceed those in radial or nearly radial ones. Hence the motion will not, in general, include many orbits of small ellipticity.

This shows that such a distribution will be unstable, changing in the direction of concentration at the centre. For a cluster where the distribution is of the form $e^{-h^2r^2}$ these considerations are modified, and it can be shown that for small amplitudes the radial orbits suffer less by collisions than the circular, while for large amplitudes the reverse conditions hold. A. Wh.

487. *Dynamics of Spiral Nebulæ.* **C. Parvulesco.** (Comptes Rendus, 181. pp. 653–655, Nov. 9, 1925.)—The initial conditions of spiral nebulæ are little known and the trajectory cannot be determined from them, but the spirals themselves outline the trajectories, and, knowing their structure, may indicate the dynamical conditions governing them. Expressing the plane curve in terms of the time, t, $[S = f(t)\,;\ R = \phi(t)]$, where S is the arc and R the radius of curvature, the velocity (v) and the accelerations (tangential γ_T and normal γ_N) are derived immediately. By varying the forms of $f(t)$ and $\phi(t)$, the resulting curves may be made to fit the observed spirals. If S and R both increase with powers of t: $S = c_1t^p$; $R = c_2^q$ (c_1, c_2 and p all positive): then $v = c_1pt^{p-1}$; $\gamma_T = c_1p(p-1)t^{p-2}$; $\gamma_N = c_1^2p_1^2c_2^{-2}t^{2p-q-2}$; near the nucleus in a limited region $p = q$ (v. Palen and Groot find that these arcs correspond to logarithmic spirals), and the ratio $\gamma_T : \gamma_N$ is constant and the arc described is proportional to R. Where $p = q$ and both > 1, then S, R and v all increase with increasing t, as found by Pease spectroscopically at some distance from the nucleus of the Andromeda nebula. Where $p = q$ and both > 2 the accelerations also increase with t, implying the existence of repulsive forces in the spiral. For the periphery, $0 < p < 1$ and $q < 0$, and both v and R must decrease as t increases. Where $p = 1$ and $q = 0$, then $\gamma_T = 0$ and v, R and γ_N are constant, and the motion is uniform and circular; these hold good for the periphery also. A. S. D. M.

488. *Methods used in Stellar Photographic Photometry at the Yerkes Observatory between* **1914** *and* **1924.** **J. A. Parkhurst** and **Alice H. Farnsworth.** (Astrophys. J. 62. pp. 179–190, Oct., 1925.)—Plates taken in focus gave photographic magnitudes on ordinary Seed plates without colour-filter, and photovisual magnitudes on Cramer Isochromatic plates behind yellow filters. Parallel-wire objective gratings gave the scale independently on each plate by comparison of the central image with the first-order spectra. The magnitudes were expressed in the International System either by direct comparison with the North Polar Sequence or indirectly by the use of the Potsdam photometric *Durchmusterung* and a spectral classification found from objective-prism plates. AUTHORS.

489. *Note on the Distribution and Number of Nebulæ.* **F. H. Seares.** (Mt. Wilson Observat. Contrib. No. 297. Astrophys. J. 62. pp. 168–178, Oct., 1925.)—A discussion of Fath's counts of nebulæ [see Abstract 1233 (1914)] on photographs of Selected Areas 1 to 139 (limiting magnitude of stars on the optical axis = 18·6, international photographic scale) shows that non-galactic nebulæ make their appearance in both hemispheres at about 20° galactic latitude. They increase rapidly in frequency to 30°, and thereafter more slowly to 70°. The concentration in the region N. 70°–N. 90° is pronounced; the corresponding region S. 70°–S. 90° is not covered by the counts. For galactic latitudes 0°–70° the average surface density in the southern hemisphere (longitudes 180°–360° unobserved) is three-fourths that in the northern. The distribution in longitude is complicated, but a band of high frequency apparently crosses the northern hemisphere in longitudes 50°–220°. A grouping of the counts in 39 fields for regions 10′ × 10′ according to distance from the centre of the plate shows that at 35′ distance the loss arising from aberrations in the optical system is one-half. To reduce Fath's counts to limiting photographic magnitude 18·6 for stars at the centre they must be multiplied by 1·94. The revised total number of nebulæ to this limit is 210,000 for N. 70°–S. 70°, and about 300,000 for the whole sky.

AUTHOR.

490. *On the Cause of Star-streaming.* **B. Lindblad.** (Astrophys. J. 62. pp. 191–197, Oct., 1925.)—Assuming tentatively a law for the velocity-distribution in the big stellar universe, the possibility of radial stream-motions due to encounters of stars with vast local accumulations of matter is shown.

AUTHOR.

491. *Star Streams.* **C. V. L. Charlier.** (Ark. f. Mat. Astron. och Fysik, Stockholm, 19. 16. [23 pp.], 1925. In English.)—The author has previously shown that the observed proper motions of the stars brighter than the sixth magnitude is not consistent with the hypothesis put forward by Kapteyn and Eddington that the Galaxy is composed of members of two star streams of approximately the same numerical magnitude. In this paper an analysis is made of the data available, using proper motions, distances and radial velocities. There are 1418 stars included. It is found that the observations are in accord with the existence of two Maxwellian components containing 91 % and 9 % of the stars observed. Analysis into two ellipsoidal components would also be possible, but this is not considered as justifiable till the requisite quantities are known for all stars down to the sixth magnitude. The velocity of the greater component is 5·55 km. per sec. towards a point in the galactic plane of galactic longitude − 18°·8 in Sagittarius. The dispersion is 16·06 km. per sec. In the lesser component the velocity is 55·93 km. per sec. in nearly the opposite direction. The dispersion is 29·56 km. per sec. It seems possible that the smaller stream may coincide with the Taurus cluster, which has similar components. The whole of this stream cannot be associated with this cluster, as the dispersion is too great.

A. Wh.

492. *Note on a Stellar Line at* 4470·046 Å. **O. Struve.** (Astrophys. J. 62. pp. 198–201, Oct., 1925.)—Stellar spectra of types O9–B3 show a faint absorption line on the violet side of the helium line 4472. The wave-length of this line was found to be 4470·046 Å. on Rowland's scale. In stars which have broad and diffuse lines the faint line at 4470 is blended with the helium line and tends to vitiate velocities determined from that line. The suspicion that this line might be due to ionised lithium could not be established at present.

AUTHOR.

493. *Properties of Matter in Stellar Interiors.* **R. H. Fowler** and **E. A. Guggenheim.** (Roy. Astron. Soc., M.N. 85. pp. 939–970, Oct., 1925.)—*Part I.*—The degree of ionisation of any kind of atom at the pressures and levels assigned by theory at any level in a star are calculated, and the mean molecular weight is evaluated. The equation for dissociative equilibrium derived by Fowler is applied to a series of examples. The method commences by assuming a value for the average degree of dissociation, and finally determines the density corresponding to the other conditions. Tables are given showing temperatures, densities, assumed compositions, free electrons per c.c. and per atom, the mean molecular weight and the chief states of ionisation. This is done for various radii within a typical giant, for the centres of stars of the same mass but varying radius, and for four typical Cepheids. In all these cases the elements considered are oxygen, iron and silver, although a few cases include hydrogen in order to show the small influence even a considerable hydrogen content has on the mean molecular weight. A table is also given for zinc and bromine, to show the change in the distribution of the stages of ionisation with change of atomic number. In this connection the values for the successive ionisation potentials are calculated after Hartree. The mean degree of ionisation of any element is almost independent of the presence of other elements. The deviation of the behaviour of the stellar material from the perfect gas laws is discussed. The most important deviation is due to an electrostatic term diminishing the pressure. The compressibility probably begins to fall off appreciably at densities of 50,000 in stars of 1½ times the mass of the sun and rather sooner in less massive stars.

Part II.—The form of the (P, V) adiabatics is considered for application to Eddington's theory of pulsating stars (Cepheid variables). A method is developed by which the values of γ corresponding to varying conditions may be determined. A table showing the values for γ for twenty-two different stellar examples is given. For each the value corresponding to H, O, Fe, Zn, Br, Ag and material of mean molecular weight 2·2 is calculated. For stability γ must exceed 1·33. Actually it does not in the range corresponding to the loss of certain shells of electrons (principally the L shell) in various elements of atomic numbers between 25 and 45. Only if a star consists largely of elements whose critical stages of losing the L shell happen to overlap, will γ be materially reduced below the value for a non-dissociating gas of the same mean molecular weight. A. Wh.

494. *Correlation between Proper Motions and Radial Velocities.* **W. Gyllenberg** and **K. G. Malmquist.** (Ark. f. Mat. Astron. och Fysik, Stockholm, 19. 11. [36 pp.], 1925. In English.)—An investigation of the motions of the stars based on a simultaneous treatment of proper motions and radial velocities. The material is derived from the Lund Observatory Card Catalogue, in which for every star the magnitude, spectral type, and motion are assigned. The stars' coordinates and proper motions are transformed to the galactic system; the sky is divided into forty-eight squares of equal areas; the proper motion components, reckoned along increasing galactic longitude and latitude, are expressed in "reduced measure" (reduced to apparent magnitude 0·0) by multiplying with the factor $10^{0 \cdot 2m}$; only stars brighter than the sixth magnitude, and of spectral types B, A, F, G, K, M (2189 in number) are considered; and known star streams (such as the Ursa Major or Taurus streams) are included. From the reduced proper motions and coordinates of the 2189 stars are derived for the sun's apex: L = 29°·4 ± 2°·6, B = + 21°·9 ± 2°·4, A = 271°·9 ± 3°·0, D = + 35°·2 ± 2°·4; from the radial velocities, L = 23°·4 ± 2°·1, B = + 21°·0 ± 2°·0, A = 270°·6

$\pm 2^\circ{\cdot}3$, $D = +29^\circ{\cdot}7 \pm 2^\circ{\cdot}0$, $S = 4{\cdot}211 \pm 0{\cdot}147$, and $\Theta_1 = 0{\cdot}6094 \pm 0{\cdot}0333$; where L and B are galactic longitudes and latitudes, A and D are R. A. and Dec., S is the sun's velocity in siriometers, and Θ_1 the mean parallax expressed in inverse siriometers (1 siriometer/stellar year = 4·7375 km./sec.). The declinations of the sun's apex from the proper and radial motions differ by 5°·5, and these might be brought into harmony by a systematic correction to the proper motions of the form $\Delta = G \cos \delta$, where G is now found to be $+0''{\cdot}0061 \pm 0''{\cdot}0032$, as compared with Kápteyn's value, 0″·0136. In the combined treatment of the reduced proper motions and the radial velocities, consideration is given to galactic and non-galactic stars; tables contain the values of stream motion components and solar velocity, the mean parallaxes expressed in inverse siriometers, the galactic coordinates of the apex, and the corrections to K for all squares, for galactic and for non-galactic squares, and for stars of types A, F, G (giants), K and M. It is found that there is an abnormally large difference in S and Θ for A and G stars where galactic and non-galactic squares are compared; this may be due to the existence of a stream so situated that the sun's motion from radial velocities is particularly influenced, but not that from proper motions. The fact that a certain part of the sky produces a peculiar direction of the sun's motion raises the suspicion that the deviation is caused by a local star stream, and it may be possible to separate the two groups.

A. S. D. M.

495. *Stellar Evolution.* **A. Brill.** (Zeits. f. Physik, 34. 9. pp. 676–683, 1925.)—H. N. Russell has suggested a new theory of stellar evolution [see Abstract 2244 (1925)], founded upon the hypothesis that matter is transformed into radiant energy, and upon a comparison of stellar temperatures computed from Eddington's theory of radiative equilibrium. All ordinary dwarf stars have a nearly equal central temperature of about 30 million degrees, but the temperature of giants is only from about 3 to 8 millions. Russell's suggestion is that giant stars transform some easily convertible kind of matter, dwarfs the main mass of stellar material, and white dwarfs a residue of specially refractory matter, into radiant energy. It is pointed out that the constancy of $k\sqrt{\epsilon}$ for all stars, which was proved in a former article by the present writer [Abstract 1845 (1925)], is of great significance for the problem, since from this constancy it results that the mean energy-production depends practically upon mass alone; and therefore Russell's hypothesis of different kinds of matter convertible into energy at different central temperatures is not necessary to explain the observations. It is sufficient to assume that star-material is convertible into radiant energy, and the greater the mass available the greater the energy. Whether the existence of white dwarfs demands the presence of a specially refractory kind of matter remains doubtful; but in any case so few of these are known at present that it is difficult to say whether they ought to find a place in the main sequence on the dwarf branch.

M. A. E.

496. *Effective Stellar Temperatures by "Prism-crossed-by-grating" Method.* **W. M. H. Greaves** and **C. R. Davidson.** (Roy. Astron. Soc., M.N. 86. pp. 33–40, Nov., 1925.)—The absolute temperature, T, of a star can be determined by Planck's formula, $I_\lambda = C_1\lambda^{-5}/(e^{C_2/\lambda T} - 1)$, from the ratio $I_\lambda/I_{\lambda'}$, where I_λ is the light intensity for wave-length λ.

The measurement of such a ratio may be effected by comparison with a black-body source of light of known temperature. The present study is an extension of the photometric method of determining stellar magnitudes (0·4 times the logarithms of the corresponding light intensities) by the coarse diffraction grating to the spectro-photometric work, by introducing a coarse grating whose dispersion is at right angles to the dispersion of a prism. On the photographic plate there are obtained flanking spectra to the main central spectra, and the magnitudes of these spectra for any given λ will differ from that of the central spectrum by a known amount. The instruments at Greenwich are described, a half-watt incandescent electric lamp being employed as intermediary for comparison with both stars and arc. The magnitudes, E_1 and E_2, E_3 and E_4, are connected with density deposits D_1 and D_2 of the stellar central spectrum, and D_3 and D_4 of the lamp, by $E = a + bD + cD^2$, where a, b and c are constants for plate and λ. A diagram shows plots of $E_\lambda - E_{\lambda'}$ for three stars (Vega, Polaris, Arcturus) and the lamp against the reciprocal of wave-lengths in the case of two plates (A and B) whose gradients are derived by adjusting the closest-fit straight line to each curve. Preliminary results give for the three stars absolute temperatures of about 16,000°, 5600° and 4400°, but these values are not final.

A. S. D. M.

497. *Equilibrium produced solely by Radiation is impossible on Sun or Stars. Internal Equilibrium is Isothermous and Homogeneous.* **A. Véronnet.** (Comptes Rendus, 181. pp. 710–712, Nov. 16, 1925.)—A study of radiative equilibrium of a gaseous mass undisturbed by convection currents. If R_1 is radiation at the surface, R at any point, I the intensity of radiation in direction θ at this point, and a the coefficient of absorption, then $I = R - R_1 \cos\theta$; $dR/a\rho dr = dR_1/a\rho dr = -R_1$. This would give a greater darkening towards the sun's limb than is observed. Integrating the differential equation: $T^4/T_1^4 = am + 1$; $4T^4/3T_e^4 = ap/g + 1$; $4dT/T = dp/p$, where T_e is the star's effective temperature and T_1 the limiting temperature at the superficial layers. The first formula holds rigorously from surface to centre; the second is valid from surface to a depth where the variation of gravity (g) may be neglected; the differential formula is independent of all these coefficients and is valid nearly to the centre. Introducing into the general differential equation of true gases [see Abstract 1111 (1924)], the variations of temperature and density are given in terms of the depth on the hypothesis of radiative equilibrium: $dT/dr = -g\mu(1 - \rho/\rho_0)/4R$; and $d\rho/dr = -g\mu\rho(1 - p/3R \times db/dT)(1 - \rho/\rho_0)^2/4RT$, where b is the co-volume. The bracket containing db is at first positive, vanishes, and then changes sign, when the pressure p becomes great enough. The density ρ, at first increasing, also decreases subsequently with the depth. The equilibrium is disturbed above this critical layer, and the lighter layers rise. If b or the limiting density ρ is varied with the temperature, the density decreases until its value becomes three-fourths of the limiting density of the gas. This will hold only for pressures of several thousand atmospheres and for depths of several hundred kilometres. The author concludes that radiative equilibrium is impossible either in the interior or at the surface of the sun.

A. S. D. M.

LIGHT.

498. *On the Estimation of Maximum Coefficients of Absorption.* **R. C. Tolman.** (Phys. Rev. 26. pp. 431–432, Oct., 1925.)—On the basis of the correspondence principle it is shown that Einstein's coefficient of absorption can be estimated from the equation $B_{na} = 2\pi^3 e^2 Q^2/3h^2$, where e is the charge and Q the amplitude of the virtual oscillator which corresponds to the transition by absorption from state S_n to S_a. Assuming that probable maximum values can be obtained by taking e equal to the charge of one electron and Q equal to 3×10^{-8} cm., we obtain $(B_{na})_{\max.} = 10^{20}$ in c.g.s. units, in agreement with values from 10^{14} to $2 \cdot 3 \times 10^{19}$ previously calculated by the author from absorption data.

AUTHOR.

499. *Absorption Coefficients and the Thickness of the Absorbing Colour Layer.* **A. Predwoditelew** and **W. Blinow.** (Zeits. f. Physik, 35. 1. pp. 38–49, 1925.)—The object of the paper is to verify experimentally the assumption that a periodic change in the absorption coefficient will cause a periodic change of the light current and of bleaching of the dye-stuff. [See Predwoditelew and Netschajewa, Abstracts 663 and 1860 (1925).] The method of preparing the thin layers of coloured material—fuchsin and crystal violet—is described. The absorption coefficient k was measured with a König-Martens spectrophotometer, employing the formula $ck = 2[\log \tan \alpha - \log \tan \alpha_0]/\log_e$, where c denotes the quantity of dye-stuff per unit area of the surface of the film. The law for the absorption of light is $J = J_0 e^{-(kc+b)}$, where $J_0 e^{-b}$ is the correction for the absorption of the collodion with which it was necessary to mix the dye-stuff. Curves are given from the results of the experiments, and these clearly show the periodic dependence of k on the concentration c. The remainder of the paper is an attempt to give a mathematical explanation of the phenomena based on the Helmholtz-Drude equations and the Lorentz time relation.

T. B.

500. *Transparency of Synthetic Resin (Bakelite) to Different Radiations.* **J. Risler.** (Comptes Rendus, 181. pp. 782–783, Nov. 21, 1925.)—The bakelite used was in the form of a slab 2 mm. thick, which had been subjected to a pressure of 150 kg. per sq. cm. Tests of the transparency were made in the red and ultra-violet regions. The transparency for the latter is lost after prolonged exposure to daylight and rapidly disappears under a source rich in ultra-violet light. The change is due to polymerisation of the formaldehyde under the photoelectric effect of the ultra-violet light, and extends to a maximum depth of 0·7 mm. Removal of a layer of this thickness restores the transparency. If the slab is not compressed and is dyed with a solution of safranine of strength 1 per 1000, its transparency for the red and infra-red is very similar to that of the Wratten red β filter.

R. S. R.

501. *The Cosine Law.* **T. Smith.** (Optical Soc., Trans. 26. 5. pp. 281–284; Disc., 285–286, 1924–1925.)—Objections raised to the author's statement [Abstract 1065 (1925)] that rays selected by a cosine relation determine caustic surfaces in the object and image spaces, and to some points in the proof of the cosine law, are considered in some detail; and the adoption of the original enunciation of the theorem is justified as opposed to the modified form suggested by Hertzberger and approved by Boegehold. A direct derivation of the analytical form of the law of refraction from the cosine law is given. A. D.

502. *The Cosine Law.* **H. Boegehold.** (Optical Soc., Trans. 26. 5. p. 287; Disc., 288, 1924–1925.)—The cosine law can be proved for and applied to more general cases than a parallel displacement, at least in the special cases of normal bundles. Application to the generalisation of the sine condition by Staeble and Likotsky (Czapski, "Theorie der optischen Instrumente," p. 253). A. D.

503. *The Molecular Refractions of Simple Compounds.* **K. F. Herzfeld** and **K. L. Wolf.** (Ann. d. Physik, 78. 2. pp. 195–203, Nov., 1925.)—The molecular refractions of simple salts with ions similar to those of the inert gases are calculated by the aid of dispersion data obtained from sodium and potassium chlorides. In addition the electronic number of the ion is required and its particular frequency. The former is assumed to be that of the corresponding inert gas, but for the calculation of the latter the Coulomb part of the respective lattice energy is added (anion) to or subtracted (kation) from the electronic affinity (anion) or work of ionisation (kation) respectively. The strengthening of large anions by small kations and the loosening effect on large kations by small anions, as found by Fajans and Joos [see Abstract 2239 (1924)], are confirmed. On the above hypotheses the calculations of the molecular refractions of the entire alkali halogenides are rendered possible, and, for the most part, are in excellent agreement with the experimental data. As exceptions, however, the theoretical results are too small for salts with large anions and small kations. Data are also included for the oxides of the alkaline earths and the hydrogen halides. H. H. Ho.

504. *Light of the Night Sky. II.* **(Lord) Rayleigh.** (Roy. Soc., Proc. 109. pp. 428–444, Nov. 2, 1925.)—The paper continues, with small correction, the work of a previous paper [see Abstract 2947 (1924)], extending it to cover observations of the night sky in England over a range of nearly 2½ years. The intensities of the various chromatic components of the light undergo important variations when measured against a fixed terrestrial standard and also when measured against one another. Extreme ranges are 3·7 to 1 (orange-red), 4·7 to 1 (auroral region near λ5578) and 2·6 to 1 (blue). The correlation coefficients for the auroral intensity are aurora-red 0·70, aurora-blue 0·66 and aurora-photographic (λ4300) 0·44. The auroral intensity is not correlated appreciably with the degree of magnetic disturbance or with the height of the barometer. The connection with sunspots, if any, is not yet apparent. The intensity does not vary measurably with the sun's distance below the horizon, within the limits, evening and morning, when twilight is excluded. Parallel observations of the auroral intensity made over some months by H. D. Babcock at Pasadena and at Mt. Wilson show values in the mean more than double those prevailing in England. There is a considerable suspicion of an annual periodicity, high values occurring before the end of November and low values afterwards. An extended scheme for observation over the globe is in progress. W. H. Ge.

505. *Accommodation.* **E. F. Fincham.** (Optical Soc., Trans. 26. 5. pp. 239–265; Disc., 265–269, 1924–1925.)—Deals with the changes in the form of the crystalline lens of the human eye in accommodation. Measurements of the radii of curvature of both anterior and posterior surfaces of the lens and also of the movement of the apices are made. In two selected cases of men of the same age and having the same refractive error considerable differences in the behaviour of the lens were found. The results show that for a given amount of accommodation, whereas the lens surfaces in one case are more increased in curvature than in the other, their apices suffer less movement. It was also found that the surface which was most altered in curvature showed the most pronounced hyperbolic form in both relaxed and accommodated conditions. The elastic property of the lens capsule and its variations in thickness are described. The changes in the form of the lens surfaces and the differences which occur in the lenses of different individuals in accommodation are explained upon the assumption of the Helmholtz theory by taking into account the properties of the lens capsule. W. H. Ge.

506. *New Optical Phenomenon shown by Biaxial Crystals.* **S. R. Savur.** (Phil. Mag. 50. pp. 1282–1296, Dec., 1925.)—Deals with the Raman-Tamma phenomenon [see Abstract 1575 (1922)]. A cathetometer is used instead of a screen, and it is found that the various appearances depend *only* on the distance between the plane on which the cathetometer is focused and the pinhole, so that the appearances are independent of the position of the crystal plate between the cathetometer and the pinhole. The phenomenon is observed under conditions when no external conical refraction could be exhibited. These two results are believed to be inconsistent with the explanation given by the original workers, and the theory of another explanation is given. Quantitative results predicted by its aid are found to agree fairly well with experimental values.
W. H. Ge.

507. *The Play of Light in a Sphere of Spar of Large Diameter.* **Turpain** and **de B. de Lavergne.** (J. de Physique et le Radium, 6. pp. 259–263, Aug., 1925.)—By projecting a narrow beam of light through a sphere of spar (diameter 5 cm.) the images produced for varying angles of incidence with the crystal axis were found to form well-defined patterns. The position of the tangent to the ellipsoid of Huyghen's surface was determined by a graphical construction for incidence perpendicular to and parallel with the axis. The patterns for any angle of incidence can be derived by the use of a method depending on a generalisation for the passage of light through an optically homogeneous sphere. Examination of the sphere with polarised light gave results in accordance with theoretical considerations. **Erratum** (*ibid.*, p. 368, Nov., 1925). J. L. H.

508. *Notes on Optical Constants.* **C. G. Darwin.** (Cambridge Phil. Soc., Proc. 22. pp. 817–831, Nov., 1925.)—In a recent paper [see Abstract 829 (1925)] the author made an attempt to reduce the ordinary optical constants of matter to a more primitive form by introducing "scattering indices." Their use solves half the problem of optics, since general formulæ connect these indices with the behaviour of matter in bulk. There remains, however, the deduction of the scattering indices from whatever is assumed to be the reaction to light of the actual atoms, and in this connection the first part of the paper is devoted to the optical behaviour of certain atomic models. By this means difficult arguments about the polarisation of the medium, which play a part in the ordinary presentation, are avoided. The essential point which simplifies the process is that the wave given out by each atomic model is spherical. By use of the model with which Lorentz obtains the ordinary dispersion formula it is shown how the magnetic gyration of light can be connected with the idea that magnetism is equivalent to a rotation. Drude's hypothesis of molecular currents is then investigated.

The second part of the paper deals with the lateral scattering from a gas. The late Lord Rayleigh worked out the effect on the polarisation of non-spherical molecules, and the present note is practically a repetition of his work, but with greater generality. The calculations depend on the fact that laterally the waves from the molecules are all out of phase, and therefore the intensity is simply the sum of the intensities from each of them. The total intensity can be measured, but the most accurate observation is to study the degree of polarisation observed at right angles to the incident beam. This has been done by the present Lord Rayleigh, and a short discussion of his results is now given. Application of the results is then made to the experiments of Rayleigh on hydrogen, nitrogen, oxygen and carbon dioxide. It is shown that the abnormal scattering afforded by oxygen is not due to magnetism, while as yet unexplained.

H. H. Ho.

509. *Apparatus for the Direct Registration of Absorption Curves of Various Substances.* **C. Müller.** (Zeits. f. Physik, 34. 11–12. pp. 824–832, 1925.)—A method, developed at the Reichsanstalt, is described for registering directly certain spectral effects, in particular absorption curves of coloured substances and coloured glasses, care being taken to eliminate sundry sources of error. The importance of the new method consists partially in the fact that sensitivity curves are obtained directly next to the absorption curve in process of investigation, partial intensities of the original energy distribution being used as coordinates. Slow variations of sensitivity, intensity, and zero-points are rendered harmless since the absorption and standard deflections are made alternately. The method consists in illuminating a photoelectric cell from a monochromator and registering on a photographic plate the deflection of a thread electrometer. The substance under investigation is then inserted and the deflection again registered along with deflections due to 100, 80, 60, 40, 20 and 0 % of the original beam, fractional intensities being obtained by means of a rotating disc suitably cut. The relative absorption may then be obtained by interpolation. On making a number of observations for different wave-lengths the absorption curve of a substance may be obtained directly, the errors previously mentioned being minimised. Fairly full experimental details are given. W. V. M.

510. *A Precision X-Ray Spectrometer for Chemical Investigations.* **G. L. Clark, H. C. Weber** and **R. L. Hershey.** (Indust. and Engin. Chem. 17. pp. 1147–1150, Nov., 1925.)—A description of equipment installed at the Massachusetts Institute of Technology and details of technic recommended for similar installations. The source of power is a bank of storage batteries having a capacity of 260 ampere-hours and 110 volts. These batteries are connected to a motor generator consisting of a direct-current motor driving an alternating-current generator, the current from this generator going to a large transformer delivering current at 240,000 volts on its output side. Mechanical, full-wave, synchronous rectification is employed and the high-tension energy fed into a system of the "brute-force" type. Full descriptions are given of the spectrometer, with special reference to the means adopted for measuring the angular settings of crystal table and ionisation chamber to 0·2 second. The electrometer employed is of the familiar quadrant type with a potentiometer device for bringing the mechanical and electrical zeros of the instrument to coincidence. The make-and-break switch, shielding and ionisation chamber are also described and general comments on the working of the installation are discussed. W. V. M.

511. *A Direct-reading Spectrophotometer.* **C. W. Keuffel.** (Optical Soc. America, J. and Rev. Sci. Inst. 11. pp. 403–410, Oct., 1925.)—To measure and specify colour two methods are available: (*a*) physical measurements of the stimulus; (*b*) colour-matching by means of the physiological visual stimulus. The spectrophotometer falls in class (*a*), and is independent of personal psychological factors. The second method is utilised in colorimeters. A specialised instrument of the first class, consisting of a constant deviation spectrometer, a direct-reading rotating disc photometer and a light source, is illustrated and described in detail, together with drawings showing the constructional details. A precision of ± 0·8 % to ± 1·2 % dependent upon the spectral region is claimed. The particular instrument is finding application in many industrial laboratories as well as pure science laboratories. B. J. L.

512. *A Modified Hartmann Test based on Interference.* **I. C. Gardner** and **A. H. Bennett.** (Optical Soc. America, J. and Rev. Sci Inst. 11. pp. 441–452, Oct., 1925.)—A method of determining the spherical aberration of a lens is given which requires relatively simple apparatus and gives directly the retardation of different portions of the wave-front referred to any point along the axis and in terms of the wave-length of the light employed. Data are given from which a convenient self-contained apparatus can be built to serve as an attachment on an optical bench of usual design. The method is based upon interference phenomena, and the bench does not need to be provided with scale or micrometric measuring devices. With the attachment built as suggested, in addition to its dimensions, the measurement of the photographic plate gives all the data required, and the one necessary exposure provides a permanent and complete record of the test. AUTHORS.

513. *Diffraction by Line Screens.* **L. R. Wilberforce.** (Phil. Mag. 50. pp. 967–970, Nov., 1925.)—An examination of the "line screens" which are used in process photography shows that they are remarkable for the accuracy of their spacing, the sharpness of the edges of the lines and the uniformity of the ratio of width of the transparent and opaque portions. They can be obtained with as many as 600 lines to the inch, and can be used as diffraction gratings. If used dry they may show an abnormally long series of spectra, and so give angles of diffraction large enough for fairly accurate measurement, and if mounted in cedar-wood oil, they will behave like the ideal grating of elementary theory. Spectrum and micro-photographs are reproduced. W. H. Ge.

514. *Deviations from Bragg's Law in the Case of Mica Crystals.* **A. Larsson.** (Ark. f. Mat. Astron. och Fysik, Stockholm, 19. 14. [10 pp.], 1925. In German.)—Describes in detail the method of adjusting the crystal and taking the measurements, so as to eliminate any effect due to lack of coincidence between the axis of the crystal table and the axis about which the photographic plate and the precision scale can be rotated. If Bragg's law is correct log $(\sin \phi_n/n)$ must be constant. Ewald has deduced the formula log $(\sin \phi_n/n) = C + A/n^2$, where C and A are constants. Theory gives $A = 6\cdot20 \times 10^{-4}$ to $7\cdot50 \times 10^{-4}$, taking the limits 1·65 to 3·2 given by Landolt and Börnstein for the density of mica. The experimental value obtained by the author is $A = 6\cdot30 \times 10^{-4}$, which lies between the two limits. The agreement is also good when the different orders of reflection are considered. If the deviation from Bragg's law is regarded as a phenomenon due to refraction, and the refractive index $\mu = 1 - \delta$, then the mean value obtained for δ by combining observations of the first order with those of all the other orders is $\delta = 8\cdot57 \times 10^{-6}$ for $\lambda = 1537$ X units while the theory gives $\delta = 8\cdot48 \times 10^{-6}$ to $10\cdot2 \times 10^{-6}$. H. N. A.

515. *On the Quantum Theory of the Polarisation of Resonance Radiation in Magnetic Fields.* **J. H. van Vleck.** (Nat. Acad. Sci., Proc. 11. pp. 612–618, Oct., 1925.)—The theory is a direct consequence of the quantum theory of the Zeeman-effect, which may be either normal or anomalous. The paper refers to two interesting consequences of this quantum theory of polarisation: (1) The quantum theory gives the same angle, 54·7°, of no polarisation as does the classical theory provided the hypothesis of "spectroscopic stability" is valid; (2) the recent experiments by Ellett and others on the amount of polarisation of sodium D resonance radiation are in good accord with the theory for determining transition probabilities developed by various writers [see Abstract 1879 (1925)]. According to the so-called hypothesis of "spectroscopic stability" (referred to above) the resultant polarisation due to the superposition of the various components is also zero in the presence of a magnetic field provided that the primary radiation remains unpolarised and isotropic. The type of excitation considered in the paper is that which is accomplished by a directed beam of light. A simple mathematical proof is given that if the electric vector E of a plane-polarised primary beam makes an angle 54·7° with the direction of the applied field H, then the resonance radiation is unpolarised. The mathematical theory is then extended to the determination of the polarisation for an arbitrary angle θ between E and H. T. B.

516. *The Scattering of Light in Mixtures of Air and Carbon Dioxide.* **Durgadas Banerji.** (Phys. Rev. 26. pp. 495–499, Oct., 1925.)—A beam of sunlight was focused in a tube containing the mixture, and the intensity of the transversely scattered light was determined by comparison with a piece of blotting-paper illuminated by diffuse light from the same beam, of which the intensity was varied by means of an iris diaphragm. The intensity varies linearly with the percentage of CO_2. By using a nicol the ratio of the intensities of the components polarised in horizontal and vertical planes was found to vary in accord with the theory of scattering by mixtures of anisotropic molecules as developed by Raman.

AUTHOR.

517. *Photoelectric Photometry.* **Research Staff of the General Electric Co., London.** (Journ. Sci. Instruments, 3. pp. 2–6, Oct.; 38–42, Nov., and pp. 77–86, Dec., 1925.)—The work described has been conducted by N. R. Campbell and E. G. New in continuation of that previously reported [see Abstract 1024 B (1925)]. A new form of cell is described, the proportionality between stimulus and response having been improved by the adoption of a central plate as kathode. The proportionality is still not exact, neither has it been confirmed, as previously announced, that the frequency-sensitivity curve is invariable for any given metal. Accordingly the cells can only be used for the comparison of lamps of nearly the same colour and intensity. A method of using such a comparison to cover all lamps of whatever intensity or colour is described. It is found that "current-equivalents" (*i.e.* currents giving the same filament temperature) can be determined to 2 parts in 10,000 (0·3° K in temperature). Flux equivalents can only be obtained to about 2 parts in 1000 owing to various causes. There are irregular differences between watt- and flux-equivalents (and therefore in efficiency at any given temperature) amounting to as much as 1 % in geometrically similar lamps, and much more in the case of different-sized lamps. These differences are due to absorption of flux by supports, cap, etc. A method of avoiding the variations due to uncertainty of contact between filament and supporting hooks is described. Finally it is shown that a rubidium cell with a suitable light filter (Wratten No. 9) imitates the sensitivity curve of the eye with considerable closeness.

J. W. T. W.

518. *Studies with the Microbalance. Part II. The Photochemical Decomposition of Silver Chloride.* **E. J. Hartung.** (Chem. Soc., J. 127. pp. 2691–2698, Nov., 1925.)—Silver chloride has now been investigated in the same manner as the bromide [see Abstract 347 (1925)]. The chloride was prepared by exposing films of pure silver deposited on vitreous silica to dilute chlorine. The results were less consistent than in the case of the bromide. The film was then put in a vacuum after removal of an atmosphere of dry air, nitrogen or hydrogen. Tables are given showing the loss in weight of such films after exposure to sunlight for various numbers of days. The maximum percentage loss of total chlorine is found to be 91·1 % in air, 89·9 % in nitrogen, and 94·8 % in hydrogen. The photochemical decomposition products are silver and chlorine; oxygen is not necessary for the action. The rates of chlorination of silver and of previously insolated silver chloride have been studied, and it has been shown that optimum concentrations of the halogen exist in each case, at which chlorination is most rapid and above which the speed of reaction rapidly diminishes with increasing chlorine concentration.

F. S.

519. *Photographic Photometry of Line Spectra.* **H. B. Dorgelo.** (Phys. Zeits. 26. pp. 756–793, Dec. 8, 1925.)—A comprehensive and valuable collective account of the author's experimental development of photographic methods of measuring the intensities of spectral lines. The law of blackening of a plate is first discussed, and a precise definition of

" blackening " and " intensity " given ($S = a + \gamma \log i$). Method A for the measurement of intensities of lines so close together as to allow of the assumption of the plates being equally sensitive to both wave-lengths consists essentially in the use of a " stepped " absorber and the comparison of the blackening of different parts of the plate. Method B for lines of widely differing λ necessitates the calibration of the plate by means of a source of illumination whose energy distribution is known. The first source described is a " black body " *in vacuo* consisting of a hollow carbon rod heated electrically and having two holes, one as the emitter and the other for temperature observations. A second " black body " of W heated by kathodic bombardment is also described. The energy distribution is obtained using a thermopile, and the plate calibrated directly. The means of measuring " blackening " by the use of a microphotometer of Hartmann, Fabry and Buisson, or particularly that of Moll, is described, giving some advantages of the latter. Results of measurements may be summed up in four rules : I. The intensity relationships of the doublets and triplet components of the sharp series is the same as that of the inner quantum numbers of the final levels. II. The sum of the intensities of components of multiple lines, which correspond to the transition of electrons to the same final state, vary as the inner quantum numbers of the final levels. III. The intensity relationships of components of lines of the Principal series are the same as the inner quantum numbers of the initial states. IV. The sum of the intensities of components of multiple lines corresponding to transitions for the same initial state are related in the same way as the inner quantum numbers of these initial states. The paper ends with interesting extensions into the domains of X-ray spectra (particularly the work of Bouwers). A bibliography of about 100 papers is included. W. V. M.

520. *Characteristics of Photographic Materials in the Ultra-violet.* **G. R. Harrison.** (Optical Soc. America, J. and Rev. Sci. Inst. 11. pp. 341–356, Oct., 1925.)—In order to develop a method of heterochromatic photographic photometry which can be used to compare line intensities at different wave-lengths in the ultra-violet, the sensitivity, speed, contrast, scale and fogging characteristics of six standard emulsions were studied in the region 4350–2144 Å. Light from a constant source (mercury-vapour lamp or cadmium spark) was dispersed in a high-aperture monochromator, and the energy distribution was measured by a thermopile and d'Arsonval galvanometer. The light was diminished in intensity uniformly at all wave-lengths by means of a diaphragm and screens. Density-log intensity and density-log time curves were plotted at fourteen wave-lengths for each emulsion, in some cases for several times of development, and from these the values of intensity contrast and time contrast were measured. All plates showed a decreasing contrast with decreasing wave-length, although some showed a minimum at 2800 Å., with somewhat increased contrast for a short distance at shorter wave-lengths. All showed an increased speed at shorter wave-lengths over that in the visible as far down as 2500 Å., when the speed for all except the Schumann plates decreased rapidly. Cramer contrast process plates, with extremely high contrast in the visible, showed greatly decreased contrast at shorter wave-lengths, though even here the contrast was greater than that of the other plates. The reciprocity law was found to hold very closely with this plate at all wave-lengths above 2500 Å. (and possibly below), over the time and intensity range studied. Eastman Speedway plates showed fairly uniform speed and contrast down to 2500 Å. These two plates were found excellent for photometry, the first having high contrast and slow speed, and the second low contrast and high speed. They showed the least tendency to acquire chemical fog of any of the plates. The Schumann plates were found unsuitable for photographic photometry, having large variations in sensitivity over their surfaces. Data are also given for several oil-coated emulsions in the region 2700–2144 Å. Oil can be used not only to increase speed and contrast at wave-lengths below 2500 Å., but to make these factors vary less with wave-length. AUTHOR.

521. *Photochemistry of Photographic Layers.* **F. Weigert.** (Zeits. f. Physik, 34. 11–12. pp. 907–917, 1925.)—A direct experiment shows that in muddy systems, such as the photographic layers for development exhibit, the introduction of an indifferent colouring matter causes a smaller strengthening of light absorption than in the clear dispersion medium of the same layer thickness. An hypothesis, which in opposition to the present results assumes a considerable strengthening of absorption in muddy systems, was put forward by Eggert and Noddack [see Abstracts 1635 and 1636 (1925)] as explanatory of their photochemical experiments on photographic layers. The proof of the invalidity of this hypothesis withdraws the basis from these conclusions, and shows that the Einstein photochemical equivalent law with photographic systems was not established by those authors. [See following abstract.] A. E. G.

522. *Photochemistry of Photographic Layer.* **J. Eggert** and **W. Noddack.** (Zeits. f. Physik, 34. 11–12. pp. 918–920, 1925.)—This paper is a discussion of the results of Weigert (see preceding abstract). It is endeavoured to show that those results are no obstacle to establishing the quantum equivalent law. A. E. G.

523. *Dissociation and Fluorescence of Iodine-Vapour.* **E. G. Dymond.** (Zeits. f. Physik, 34. 8. pp. 553–561, 1925.)—Experiments are described which show that when light whose wave-length is shorter than λ4995, and lies within the region of the continuous absorption, falls upon iodine molecules, they are dissociated into a normal and an excited atom. In addition some resonance effects in iodine are described. A. C. M.

524. *Fine-Structure of Spectrum-Lines.* **A. E. Ruark** and **R. L. Chenault.** (Phil. Mag. 50. pp. 937–956, Nov., 1925.)—Suggested explanations of the occurrence of complex lines are reviewed. Isotopy can account for some spectral fine-structures, but is not the cause of the satellites in the majority of cases studied. Variations in the orientation of the nucleus will not explain the phenomena; the alterations of fine-structure caused by the magnetic moment do not exist in the cases of hydrogen and ionised helium. Pauli's hypothesis that for non-hydrogenic atoms the nuclear field of force does not follow the inverse square law, because of the complex nature of the nucleus, leads to qualitative agreements in some cases, but does not explain the majority of the observations. The authors incline to the view that a major cause is the variation in the configuration of underlying electron shells. It is to be noted that all the elements which show fine-structures lie in parts of the periodic table in which the valence shell or underlying shell is nearly complete. Thus complex spectral levels are to be associated with a large number of loosely bound electrons. The single exception is Aluminium II, and here it is probably a relativistic cause. Other reasons are given for the contention. A digest is given of the data on complex levels for Al II, Cd, In, Tl, Cu, Pb, Bi, Mn, Br, and I. Study of fine-structures in Mn allowed several lines to be classified as all containing a complex term $y = 42682 \cdot 62$ cm.$^{-1}$. The separations of complex spectral levels are frequently in integral ratios, and in general some of the possible satellites are not observed, as if some selection principle was at work. An attempt is made to assign fine quantum numbers to the components of the spectral levels and to state selection principles. A. C. M.

525. *Rules for the Intensities of Spectral Lines.* **R. H. Fowler.** (Phil. Mag. 50. pp. 1079–1083, Nov., 1925.)—Summation rules are found by classical calculations translated into quantum expressions. Under certain conditions these rules for the intensities are exact, provided the intensities are expressed in terms of numbers of quanta per atom per second. More generally, when the conditions are not exactly fulfilled, the degree of inexactness of the conditions is also that of the intensities. Examples are considered. A. C. M.

526. *Spectral Lines of Type ms—nd.* **G. Joos.** (Phys. Zeits. 26. pp. 729–730, Dec. 8, 1925.)—The line 1*s*—3*d* of potassium can be excited during absorption at low pressures [see Abstract 325 (1923)], although this line is forbidden by the selection principle. This cannot be explained by the usual excuse that strong intermolecular fields are at work. The appearance of switches in which *k* changes by more than unity follows if the rotation of the axis of the elliptical orbit about its focus is not uniform, but occurs periodically. This is imagined thus: Suppose that the rotation of the perihelion occurs only while the light-electron is within the core, and that, while it is outside, the coordinates of the ellipse are stationary. Then the angular velocity of the coordinates will be a periodic function of the time and the fundamental period will be the same as that of the electron in its orbit, since the angular velocity of the coordinates depend only on the position of the electron in its orbit. This is treated mathematically, and leads to the conclusion that for switches where *k* is *not* $= \pm 1$, the angular velocity of the coordinates of the ellipse must depend on the angle made by the axis of the ellipse with a fixed direction in the core. This can happen if (1) the imaginary core surface is not spherical, for penetrating orbits, and (2) if for non-penetrating orbits the core-potential is not cylindrically symmetrical. Since it has been observed for a 1*s* orbit, which must penetrate, then the explanation is to be sought in case (1). For instance, one can imagine the light-electron to circulate in the meridian plane of a core having the shape of an ellipsoid of rotation. A. C. M.

527. *The Theory of the Broadening of Spectral Lines.* **Lucy Mensing.** (Zeits. f. Physik, 34. 8. pp. 611–621, 1925.)—It is shown that the mutual action between like atoms in the same quantum state is larger than that between different atoms, in consequence of commensurabilities between the frequencies of the electronic motions. The broadening of the spectral lines due to the Stark-effect caused by the molecular fields is thus greater when no foreign gas is present than when such a gas is added, if the pressure is kept constant. It is shown that the effect should be observable in the absorption spectra of the alkali metals if the theory is correct. H. N. A.

528. *Experimental Basis of the Zeeman-Effect.* **E. Back.** (Phys. Zeits. 26. pp. 833–841, Dec. 16, 1925. Paper read before the Deut. Physikertag., Danzig, Sept., 1925.)—A review of past work on the Zeeman-effect from its discovery up to the present day, with a summary of the present theoretical state of the subject. A. C. M.

529. *The Square-term Stark-Effect in the Alkali Metals.* **W. Thomas.** (Zeits. f. Physik, 34. 8. pp. 586–601, 1925.)—Mathematical. The atom-model used by Heisenberg and others to elucidate multiplet structures is investigated to obtain a formula for the square-term in the Stark-effect, with special reference to the alkali metals. The conclusions are compared with results of known experiments. A. C. M.

530. *Doublet and Triplet Separations in Optical Spectra as Evidence whether Orbits penetrate into the Core.* **D. R. Hartree.** (Cambridge Phil. Soc., Proc. 22. pp. 904–918, Nov., 1925.)—Landé [see Abstract 2503 (1924)] has indicated a connection between the relativity doublets of X-ray spectra and the doublets and triplets of optical spectra, and therefrom obtained a formula for the separation of optical doublets and triplets. It is assumed that the splitting of an n_k term of a central field into a doublet, triplet, or higher multiplet term is due to some influence which acts chiefly on the innermost part of the orbit; and in order that Landé's relation should be applicable it is essential that the orbit of the series electron corresponding to the doublet (or triplet) term should penetrate into the region of the core occupied by the orbits of the core electrons corresponding to the related X-ray doublet terms. The object of the present paper is to examine the experimental data from this point of view. It is concluded that, except for lithium-like atoms, *p* terms of all known spectra correspond to penetrating orbits, which conclusion disagrees with Bohr's assignment of quantum numbers for those terms of the spectra of neutral atoms of the Cu and Zn sub-groups. For *d* terms the evidence is not so definite, but it seems possible that for CsI and ThI the *d* terms correspond to penetrating orbits, in disagreement with Bohr's assignment. It is shown that the Landé formula seems to hold approximately for separations in multiplet spectra when the terms belong to a sequence of the Rydberg type. Ideas suggested by Heisenberg [see Abstract 2279 (1925)] would involve some modifications of the interpretations of the magnitudes of doublet separations, but at least the conclusions as to the *p*-orbits penetrating still stand. H. H. Ho.

531. *Vibration of CO_3 Group.* **P. A. Taylor.** (Phil. Mag. 50. pp. 1158–1160, Nov., 1925.)—Confirms Chapman and Ludlam's criticism [see Abstract 86 (1926)] of Kornfeld's treatment of the problem. A recalculation of constants gives less agreement with observation than that obtained by Kornfeld. F. S.

532. *Excitation of Gas Spectra by Chemical Reactions.* **H. Fränz** and **H. Kallmann.** (Zeits. f. Physik, 34. 11–12. pp. 924–950, 1925.)—Luminosity from chemical reactions is investigated, in cases where it is not of a purely thermal nature, and the fundamental processes made clear. The mercury resonance-line λ2537 was excited by the reaction sodium-vapour-chlorine, but not by sodium-vapour-bromine. No lines were evoked when mercury-vapour reacted with bromine or with iodine, but bands were seen. The bands from the mercury-chlorine reaction agreed with those seen when a discharge is passed through $HgCl_2$ vapour. Those in the case of mercury-bromine and mercury-iodine are shifted towards the red compared with the corresponding discharge spectra. Also in the chlorine-mercury reaction a second, redder spectrum can be excited. A. C. M.

533. *The Excitation of the Spectra of Nitrogen by Electron Impacts.* **D. C. Duncan.** (Astrophys. J. 62. pp. 145–167, Oct., 1925.)—The excitation of the spectra of nitrogen was investigated by two methods: (1) In low-voltage arcs in a mixture of nitrogen and mercury-vapour below the ionising potential, and (2) in a three-element tube at low pressures. The first, second and fourth positive bands appeared below the ionising potential, and are assigned to the neutral molecule. Three new low-potential systems are reported in the ultra-violet. These also are assigned to the neutral molecule. The third positive bands did not appear, and are probably due to a nitrogen oxide. The cyanogen bands were likewise absent. The negative bands appear above the ionising potential and increase in intensity with the degree of ionisation, being emitted by the ionised molecule. New bands in the ultra-violet, degraded towards the red, appear simultaneously, and, in addition to exhibiting a similar behaviour, have the same Deslandres progression, indicating a physical relationship. The line spectrum appeared above about 70 volts in ordinary arcs and as low as 35 volts in intense arcs, in agreement with the change in the rate of clean-up of nitrogen in the discharge. AUTHOR.

534. *Emission and Absorption Bands of Carbon Dioxide in the Infra-red.* **J. W. Ellis.** (Phys. Rev. 26. pp. 469–474, Oct., 1925.)—The absorption spectrum produced by a 12-cm. cell of CO_2 gas, and the Bunsen flame emission spectrum, to 3 μ were recorded by means of a new self-registering infra-red quartz prism spectrograph of an auto-collimation type. A new weak absorption band was found at 2·02 μ which forms a linear, though not a harmonic, frequency series with known bands at 2·73 μ and 4·25 μ. This was identified with a 1·99 μ flame emission band, which had been assigned by Paschen to water-vapour. The 2·7 μ emission region was widely resolved into two components of practically equal intensities, with maxima at 2·58 μ and 2·76 μ, corresponding to maxima identified by Paschen with water-vapour and CO_2 respectively. When the quartz prisms were replaced by a similar rock-salt pair the 4·4 μ emission occurred as a nearly symmetrical band, although Barker's measurements with high dispersion showed it to be double. Calculations of the Bunsen flame temperature from his observed separations gave 2000° K, in rough agreement with previous pyrometer determinations. AUTHOR.

535. *Spectrum of Li II.* **Y. Sugiura.** (J. de Physique et le Radium, 6. pp. 323–333, Oct., 1925.)—The spark spectrum of lithium was photographed using a tube with perforated kathode, the wall of the perforation being lined with LiCl. This also allowed the Stark-effect to be observed for various lithium and chlorine lines. The lithium spark lines are classified into series, according to the quantum defects of the terms; these defects are compared with the corresponding ones for helium. 1S corresponds to 67·5 volts. The critical potentials calculated from the spectral terms are satisfactorily in accord with those observed by Mohler and with those deduced from the atom-models of Bohr and Kramers. The quantum defects of Li II were also calculated theoretically and compared with the spectroscopic values. A. C. M.

536. *The Spectrum of Rubidium at Low Voltages.* **F. H. Newman.** (Phil. Mag. 50. pp. 1276–1282, Dec., 1925.)—An account of investigations on rubidium similar to those previously described [Abstracts 2294 (1925) and 297 (1926)] for sodium and potassium, whereby a line by line radiation emission corresponding to interorbital transitions involving less energy than the ionising potential resulted as the velocity of the impacting electrons was progressively increased. The experimental arrangement is as before. Theoretically it should be possible to produce separately at 1·55 – 1·58 volts the members of the first doublet of the principal series (7948, 7800), while 2·39 volts should eject the electron to the 2δ orbit, from which it returns to 1σ *via* 1π, giving rise to 15,290 and 7948, 7800. The lines should appear in the following order: λ7758, 7719; 7408, 7280; 3592, 3587; 6299, 6206; 6160, 6071, until the whole arc spectrum is produced at 4·16 volts. Experimental results show, however, that it is only possible to obtain the single line spectrum 7948, 7800 and the complete arc spectrum, the failure to observe line by line emission being due to the space charge effect of electrons lowering the impact energy except in the immediate neighbourhood of the anode. Spectrograms are reproduced and tables of results. W. V. M.

537. *Line and Band-Spectra of Copper.* **H. Stücklen.** (Zeits. f. Physik, 34. 8. pp. 562–585, 1925.)—The spectrum of the under-water spark of copper was photographed. Near to the alkali-like spectrum is one which is unlike, and which apparently consists of quartets. While the alkali-like spectrum is attributed to a 4_1 electron, this new spectrum is attributed to a 3_3 electron. Some satellites which appear with a great number of copper arc-lines are here connected with bands of instable copper molecules. It is sought to explain similarly satellites in the cases of other metals. Lines having satellites in copper have series-relationships. At λ2240·69 is a new copper absorption band. It was measured, and R and P branches were found having 58 and 42 components respectively. It is apparently a copper hydride molecule. A. C. M.

538. *Water-Spark Absorption Spectrum of Copper.* **P. K. Kichlu.** (Indian Assoc. for Cultivation of Science, Proc. 9. 3. pp. 187-192, 1925.)—The sparking cell consisted of a rectangular glass tank with a quartz window cemented over a hole in one side. The electrode supports were mounted on an ebonite cover-plate, and the upper one was movable. This spark gap was connected with a condenser and self-induction to form a high-frequency circuit, and was activated by an induction-coil. The spectrum was photographed with a small quartz spectrograph. The core of the spark is a region of high temperature and pressure, and the outer region is formed by vapour of the metal of the electrodes giving rise to reversals. Increase of self-inductance obliterates reversals and gives rise to emission lines. Pointed electrodes favour abrupt discharges showing emission lines, while flat electrodes favour the production of absorption lines. A transformer of large capacity tended to make the spectrum more continuous, especially below 2200 Å. The following lines were obtained in absorption: 3273·97, 3247·55, 2246·98, 2242·60, 2230·07, 2227·74, 2215·65, 2214·56, 2199·65, 2192·24, 2179·37, 2165·06, 2135·92, 2130·70, 2025·1. A number of pairs with constant frequency difference are noted. F. S.

539. *Absorption Spectra of Some Rare-Earth Crystals at the Temperature of Liquid Helium.* **J. Becquerel, H. K. Onnes** and **W. J. de Haas.** (Comptes Rendus, 181. pp. 758–760, Nov. 21, 1925.)—This is a continuation of previous work [see Abstract 1094 (1908)] in which the temperature has been lowered from 14° K (solid hydrogen) to 4°·2 K (liquid helium). Four uniaxial crystals—xenotime, tysonite, parisite, and bastnæsite—have been investigated. The number of bands in the absorption spectra had been shown to decrease at 14° K, and is now found to be still less at 4°·2 K. Only the case of light passing along the optic axis and along the lines of magnetic force has so far been studied. F. S.

540. *Band-Spectrum of Aluminium.* **G. Eriksson** and **E. Hulthén.** (Zeits. f. Physik, 34. 10. pp. 775–787, 1925.)—The spectrum of the aluminium arc in air and in hydrogen has been photographed with a large concave grating. The arc in air emits an intense band-spectrum, the numerous bands being divided into several groups. A small portion only of the spectrum has so far been investigated. From the structure of the bands it is suggested that the carrier is the aluminium oxide molecule. The arc in hydrogen gives a weak band-spectrum with bands at λλ4067, 4241, 4354 and 4568. Measurements are given of this aluminium hydride spectrum which it has been found possible to arrange in a system. Anomalous shifts and broadening of some lines is attributed to deformation of the molecule. F. S.

541. *Intensities and Widths in the Sodium Principal Series.* **B. Trumpy.** (Zeits. f. Physik, 34. 10. pp. 715–721, 1925.)—These were measured in absorption. The absorption coefficient and the half-width decrease with increasing order-number, the latter slightly more quickly than the former. The line-widths are most dependent on the concentration of the sodium-vapour; to a less degree on the total gas-pressure. This is difficult to understand from the Lorentz collision theory point of view, but can receive an explanation if we assume (classically) that the resonators are not free, but coupled. [See next Abstract.] The probability-factor b_{ik} is worked out for the switches 1*s*—4*p*, 1*s*—5*p* . . . up to 1*s*—13*p* by graphical integration of the absorption curves. If a_{ki} is the probability of a sudden return from state k to state i, then the product $\frac{g_k}{g_i}a_{ki} = \frac{8\pi h\nu^3}{c^3}b_{ik}$, using Einstein's formula. In this, a_{ki} and b_{ik} decrease very rapidly with increasing order-number. It is found that $g_k a_{ki}/g_i$ is given quite well by constant/n^3, where n is the total quantum number of the greater orbit. A. C. M.

542. *Absorption in Sodium-Vapour.* **J. Holtsmark.** (Zeits. f. Physik, 34. 10. pp. 722–729, 1925.) It is shown that if the interatomic "coupling forces" between atoms of the vapour which it is absorbing are treated classically, a broadening of the absorption lines follows. The lines of the principal series of sodium and other elements are very much broadened by increasing concentration of sodium-vapour, as is to be expected on the Lorentz collision theory. If the absorption is considered as being due to classical oscillators which are coupled, then the broadening can be calculated, and is found to agree with the observed values. For small values of the concentration of sodium-vapour it is proportional to the square-root of the concentration. Similar conclusions must hold for emission lines, and also for the emission and absorption lines of solids or liquids. [See preceding abstract.] A. C. M.

543. *Interpretation of the Spectra of the Alkaline Earths.* **G. Wentzel.** (Zeits f. Physik, 34. 10. pp. 730–735, 1925.)—Recent work by Russell and Saunders [Abstract 1382 (1925)] has added greatly to previous ideas on the theory of multiplets. The present paper consists of a discussion of the structure of the arc spectra of the alkaline earths and allied spectra. Thus the spectra of Sc^+, Y^+, and La^+ show similar term regularities as Ca, Sr and Ba, but with the difference that in Sc^{++}, Y^{++}, La^{++} the d term is more stable than the s term. The question as to the normal position of the electron is the $p'd'$ terms of the alkaline earths or whether its orbit is n_3 or n_1 is discussed, and the conclusion substantiated that n_3 is the correct value. X-ray "spark" spectra are shortly discussed.
W. V. M.

544. *Absorption of Balmer Lines in Hydrogen.* **Ruby V. Jolowicz.** (Phil. Mag. 50. pp. 1089–1096, Nov., 1925.)—When an electron falls back into its second orbit in a hydrogen atom it will be in a condition to absorb a line of the Balmer series. Experiments are described in which an endeavour was made to observe such absorption. Electrons from a glowing tungsten filament were accelerated through a grid into a field-free space between the grid and a plate. Light from a Nernst lamp or from a hydrogen discharge tube was passed between grid and plate, and intensities of the light compared by Nicholson and Merton's wedge method. Two tubes were used with path-lengths of light of about 4 cm. and 50 cm. respectively. An automatic arrangement was then employed for taking simultaneous photographs with and without an accelerating field, these photographs being examined with a Moll microphotometer. No evidence of absorption was obtained, and it is concluded that the number of excited hydrogen atoms under the conditions of experiment was very small. As the accelerating field exceeded 16 volts, it is thought that the ionisation potential in this neighbourhood corresponds to molecular ionisation without dissociation. F. S.

545. *The "Life Period" of Metastable s_3 and s_5 States of Neon.* **H. B. Dorgelo.** (Zeits. f. Physik, 34. 10. pp. 766–774, 1925.)—Measurements by Hertz and Lyman and Saunders have shown that the s_3 and s_5 states of neon are metastable. The author has shown (using his methods of quantitative measurements of intensity) that the radiation from a neon tube corresponding to final states s_3 and s_4 is absorbed in a second column of excited neon. More particularly under these conditions $2s_5$—$2p$ and $2s_3 \rightarrow 2p$ are absorbed. Using the observation that so long as these lines are absorbed, atoms must be in the s_3 and s_5 states, a determination is made of the mean life of these states, the method being essentially that

of the phosphoroscope. Various results give the life of s_5 as 1/240 seconds, the life of s_3 being much shorter and roughly 1/2000 of a second. A second method (using the rectification of an alternating current, one-half wave of which is sent through the discharge tube and the other through the absorbing tube) verified the previous results, which it is shown may be expected theoretically. Analogous results are obtained with mercury.
W. V. M.

546. *Stimulation Potential of Band-Spectrum of Nitrogen.* **H. Sponer.** (Zeits. f. Physik, 34. 8. pp. 622–633, 1925.)—From electron-shock and optical measurements the stimulation potentials for the null bands of positive and for negative groups are found. A series is developed. With the aid of a hypothesis as to the nature of active nitrogen the dissociation-energy of the nitrogen molecule is estimated at 11·5 volts $\simeq$ 260,000 calories.
A. D.

547. *The Flame Spectra of Carbon Monoxide and Water-Gas. Part II.* **F. R. Weston.** (Roy. Soc., Proc. 109. pp. 523–526, Nov. 2, 1925.)—A continuation of previous work [Abstract 2507 (1925)]. A new type of flame is used enabling more intense spectrograms to be obtained. It is considered that further evidence is thus gained in support of the previous views concerning the reactions involved.
W. V. M.

548. *Atoms and X-Rays.* **F. W. Aston.** (Brit. J. of Radiology, 22. pp. 3–12, Jan., 1926. Nature, 116. pp. 902–904, Dec. 19, 1925.)—Deals in a popular manner with isotopes, ionisation, transmutation of the elements, atomic structure and atomic energy. The lecturer does not consider that it is possible to transmute mercury into gold, since millions of volts would be required to shoot an electron into a mercury nucleus, and such forces are not as yet available. There is no isotope of mercury of atomic weight 107, as previously suspected, and as Hönigschmidt has found that the atomic weight of the gold supposed to have been formed from mercury agrees within experimental error with that of ordinary gold, 197·2, it is clear that it cannot have been produced in this way, since the only isotopes of mercury are 198, 199, 200, 201, 202 and 204.
H. N. A.

549. *Dimensional Variation of Duplitised X-Ray Film.* **J. M. Cork.** (Optical Soc. America, J. and Rev. Sci. Inst. 11. pp. 505–507, Nov., 1925.)—The use of duplitised X-ray film in spectrographic work for accurate measurements, as of lattice constants, renders it necessary, when comparative methods of measurement are not possible, to know the factors which determine its dimensions. Some of the factors causing variation are humidity, temperature, treatment during development and washing and manner of drying. To test these effects parallel lines were ruled upon strip film and measurements made with a Gaertner comparator, reading to 0·001 mm., after variation of the above factors and over periods of weeks. Experiments show the humidity factor to be most important and, to a less extent, the temperature. Films should therefore receive identical treatment in washing, developing and drying, as a variation of lattice constant by 0·01 % may be masked by such film variations, which value may increase to 0·2 % owing to local distortions. The preferable use of photographic plates is advised.
B. J. I.

550. *Observations on the Spreading of X-Ray Impulses.* **A. Joffé** and **N. Dobronrawov.** (Zeits. f. Physik, 34. 11–12. pp. 889–892, 1925.)—A serious difficulty in the wave theory lies in the fact that an electron struck by X-rays absorbs an amount of energy independent of its distance from the source. In all experiments, however, a continuous or quasi-continuous radiation is employed and not single pulses. Experiments were performed using a simple type of X-ray tube of ebonite, the electronic supply being controlled by ultra-violet light falling on an aluminium kathode. Observations of the secondary electrons produced by X-ray pulses and the fact that their velocities reached the velocity of the primary electrons of the X-ray tube lead to the belief that the radiant energy of a single pulse remains within a solid angle of less than 10^{-5}. W. V. M.

551. *The Scattering Coefficient for Hard X-Rays.* **W. Bothe.** (Zeits. f. Physik, 34. 11–12. pp. 819–823, 1925.)—An electron, originally free and at rest, on abstracting an amount of energy $h\nu$ from the primary wave, attains to a velocity $\alpha = h\nu/mc^2$ (expressed as a fraction of c). This velocity is approximately the same as the "effective velocity" of Compton $(\bar{\beta})$. More accurately $\bar{\beta} = \alpha/(1 + \alpha)$ . . . . (1). The energy absorbed by the electron increases its mass, and using this conception it is shown that equation (1) may be deduced. The scattering coefficient σ may be calculated similarly. Compton has shown somewhat empirically that $\sigma/\sigma_0 = 1/(1 + 2\alpha)$, where σ_0 is the classical coefficient of Thomson. The author deduces a formula $\sigma/\sigma_0 = 1/(1 + \frac{3}{2}\alpha + \frac{2}{3}\alpha^2)$, which is in slightly better agreement with the observed values. W. V. M.

552. *X-Ray Interferences from Mixture Crystals.* **M. v. Laue.** (Ann. d. Physik, 78. 2. pp. 167–176, Nov., 1925.)—Tammann has contended that the distribution of the atoms in a mixture crystal formed from two different metals is a regular one; the author, on the other hand, considers that it is governed by pure chance [see Abstract 1257 (1918)]. In the present paper he shows that any regularity would give traces of an interference diagram of the NaCl type, with the constant $2a$; not even faint traces of this have so far been reported. The case of a mixture of gold and copper in the atomic ratio 1 : 3, which was observed by Bain to give faint interferences corresponding to a doubling of the lattice constant, may be due to the fact that a chemical compound is formed and not a mixture crystal. H. N. A.

553. *The J Phenomenon in X-Rays. Part II. Application to Scattered X-Rays.* **C. G. Barkla** and **S. R. Khastgir.** (Phil. Mag. 50. pp. 1115–1134, Nov., 1925.)—Describe experiments in which the ratio between the ionisation produced in an electroscope by the secondary radiation from paper, proceeding in a direction at right angles to the primary beam and that produced in a similar electroscope by fine pencils of the primary beam, was measured. This ratio S/P was usually very constant. Similar absorbing sheets of aluminium were then placed before the two electroscopes, and the ratio S′/P′ of the ionisations was again measured. In certain cases S′/P′ was exactly equal to S/P, while in others there was a well-marked difference between them, the change from equality to inequality was very abrupt, and was connected with the J discontinuity described previously by Barkla [see Abstract 2525 (1925)]. The experiments show that in many cases the J transformation is definitely subsequent to the emission of secondary radiation from the radiating substance. In others the radiation, when first tested, appears to have been already transformed, but the transformation is exactly like that which, in the first cases, is actually seen to occur outside the scattering substance. It seems highly probable that the displaced spectral line of the secondary radiation, as observed by Compton, is a result of the J phenomenon, and that the change is not really one in wave-length but in absorbability. The authors suggest that the "activity" of an X-radiation depends in part on a coherence of constituent radiations, and that a slight change of condition alters the activity from one definite level to another; the levels of activity depend, not on the individual harmonic constituents of a complex radiation, but on the radiation as a whole. The J discontinuities are the steps from one level to another. H. N. A.

554. *Chemical Analysis by Means of X-Ray Spectrometry.* **P. Günther** and **I. N. Stranski.** (Zeits. phys. Chem. 118. pp. 257–275, Nov. 20, 1925.)—Describes the apparatus employed in which the rotating crystal method was used. The films produced were measured photometrically, and experiments were made with mixtures of 50 % Co and 50 % Ni, with 95 % Co and 5 % Ni, and with pure nickel. If there were no action of the radiation of one metal on that of the other, the ratios of the CoK lines to the NiK lines would be unity for the 50 : 50 mixture. If, however, as theory predicts, the NiKβ_1 line is absorbed by the cobalt, the ratio CoKβ_1 : NiKβ_1 will be greater than unity, while CoKα : NiKα will be nearly equal to unity. This is due to the position of the absorption limit of cobalt, which lies between the NiKα and NiKβ_1 lines. The measurements showed the expected effect clearly, and in combination with those on pure nickel and the 95 % Co 5 % Ni mixture showed that the effect on the Kβ_1 line increased with diminishing concentration of the nickel in the absorbing cobalt. It is clear that this effect has to be kept in mind when an attempt is made to estimate the proportions of two such elements in a mixture by means of the X-Ray spectroscope. H. N. A.

555. *The X-Ray Spectroscopic Method and the New Elements, Masurium and Rhenium.* **O. Berg.** (Zeits. techn. Physik, 6. 11. pp. 599–603, 1925.)—A general review of the facts with regard to the K and L series of the elements, which have to be considered in deciding whether observed lines in the photographs are due to previously known elements or to the new elements which are looked for. When only a small quantity of an element is present considerable care has to be taken, since the K lines of one element may cover the L lines of another, or the strong series lines of the element looked for may have the same position and about the same intensity as weak series lines of a neighbouring element in the periodic table, *e.g.* the strong lines Lβ_1, β_2, β_3, β_4 of element 75 come very close to the weak lines Lβ_5 to Lβ_{12} of tungsten. Lines of different orders may also be confused. It is necessary to show, not only that the lines of the suspected new element are present, but that the ratio between their intensities corresponds to that of the same lines of the neighbouring elements. The existence of element 43 has been proved in this way by observations of three K lines, and that of element 75 by observations of four L lines, with a possible fifth line. A table gives the measured and calculated wave-lengths of these lines, the agreement being good. H. N. A.

HEAT.

556. *The Effect of Light on the Thermal Conductivity of Selenium.* **R. E. Martin.** (Phys. Rev. 26. pp. 475–485, Oct., 1925.)—Both thermal and electrical conductivities were measured for the same thin strip of Se in order to compare the effect of illumination on both. The cells were made by winding a double spiral of Pt or Ni wire on a mica form, then pressing melted Se into a thin layer over and between them by means of another sheet of mica. The thermal effect was measured by heating one winding CD by an electric current and using the other AB as a resistance thermometer. The Se was rendered light sensitive by suitable heat treatment and the cell was placed in a well-insulated box kept at 0° C. Correcting for the heating effect of the light, the rate of rise of temperature of AB was 15 to 30 % greater with the illumination than without, the percentage change for each cell being about half that observed for the electrical conductivity of the same cell for the same illumination. A cell which was not sensitive electrically was also not sensitive thermally. By using various colour screens it was found that, as in the case of the electrical sensitivity, the red end of the spectrum is more effective than the shorter wave-lengths. Sieg failed to find this effect and explained his negative result as due to the absence of an electric field, but an electric field applied by means of the winding AB was found to have no effect on the thermal conductivity. These results furnish additional evidence that thermal and electrical conductivities in metals both depend, at least to a considerable extent, upon the same factors. AUTHOR.

557. *Lecture Apparatus for Demonstrating the Thermal Transformations of Steel and the Anomalies of Special Alloys.* **P. Chevenard.** (J. de Physique et le Radium, 6. pp. 264–272, Aug., 1925.)—The small increase in brightness produced when steel is cooled through the recalescence temperature is emphasised by comparison with a ferro-nickel alloy which shows no such effect. Curves of dilation for steel showing well-defined breaks at points of transformation are obtained by the use of a wire dilatometer. The ordinates of the curves represent the changes in length of the steel wire whose arrest points are to be examined and the abscissæ the corresponding changes in a nickel-chrome wire which shows no arrest points. The wires are electrically heated to the same temperature, and the changes on cooling are combined optically by a mirror free to move about a fixed point. A thermo-magnet recorder traces by movement of a spot of light the curve of intensity of magnetisation with temperature, while the thermo-elastic oscillator and the twisted wire galvanoscope show the anomalous thermo-elastic properties of certain ferro-nickel alloys.

J. L. H.

558. *Gallium-in-Quartz Thermometer graduated to* 1000° *C.* **S. Boyer.** (Indust. and Engin. Chem. 17. pp. 1252–1253, Dec., 1925.)—Recent investigations on the properties of gallium indicated its possible use as a thermometric liquid. Formerly the wetting of glass and quartz surfaces by liquid gallium had prohibited its use, but on changing the gas-pressure above the metal, increasing its purity, removing oxide and water films, and freezing it from occluded or dissolved gases, it was found that the resulting metal was quite suitable. This paper briefly records the above experimental processes and their effects. Gallium can be supercooled to − 2° C. without solidifying, and boils about 1700° C. With 2 or 3 microns pressure it is still liquid at − 20° C. Details are given of the thermometer tube, the method of filling, and the marking and calibration. For the etching of the scale cold hydrofluoric acid was used, but the quartz tube was protected with polymerised China wood oil. The fixed points were obtained by comparison with a standard thermocouple. Sand and copper oxide gave the etching a black surface, and rendered visibility easier. The thermometer works well up to 1000° C. [See Abstract 351 B (1926).] S. G. B.

559. *Fundamental Law of Annealing.* **F. W. Preston.** (Optical Soc., Trans. 26. 5. pp. 270–273, 1924–1925.)—The fundamental law of annealing that the rate of decrease of stress varies as the square of the stress present is deduced from first principles by means of dimensional analysis, assuming (1) that the rate of decrease of stress depends only on the stress present and the viscosity; (2) that the rate of decrease of stress depends on the stress present, the viscosity and the rigidity of the material. It is shown that the law suggested as an empirical relation by L. H. Adams and E. D. Williamson [Abstract 1587 (1920)] is obtainable directly from dimensional reasoning in the form $-df/dt = \phi(f, \eta) = Bf^2/\eta$, where B is a dimensionless constant, f is the stress, and η the viscosity. C. O. B.

560. *The Annealing of Glass.* **F. W. Preston.** (Optical Soc., Trans. 26. 5. pp. 274–277; Disc., 277–280, 1924–1925.)—Consists of a remodelling on dimensional lines of a paper by H. M. Hampton [Abstract 1135 (1925)]. Assuming that the coefficient of expansion of glass is constant over the annealing range and that Twyman's law connecting viscosity with temperature accurately represents the facts over the same range, it is concluded that Hampton's results are correct and his numerical values calculated from satisfactory premises. C. O. B.

561. *Critical Miscibility and Boiling-point Elevation.* **C. Drucker** and **H. Weissbach.** (Zeits. phys. Chem. 117. pp. 209–241, Sept. 10, 1925.)—The elevations produced in the boiling-point of mixtures in various proportions of carbon bisulphide and methyl alcohol by addition of sodium iodide, urea, succinic acid, water, diphenylamine, naphthalene, azobenzene, and acetanilide are not in agreement with Nernst's theory (Zeits. phys. Chem. 11. p. 1, 1893). The deviations are smallest for the critical mixture of the solvents (36·8 mol. per cent. of methyl alcohol) and increase with the proportion of the alcohol. Positive deviations from the theoretical molecular boiling-point elevation are obtained with substances readily soluble in both the components of the solvent, and negative deviations with those substances which are virtually insoluble in carbon bisulphide. The cause of these anomalies is found to lie, not in the fact that Nernst's theory fails to take into account the heats of mixing, but in the fact that, in the present case, the composition of the vapour is not, as the theory supposes, independent of the nature and concentration of the added substance, so that the solutions may no longer be regarded as of ideal dilution.

For this salting-out of the components of the solvent there exists a simple law, in accord with ordinary actions of this nature. This effect is also related to the displacement of the miscibility temperature of the two solvents. T. H. P.

562. *Contribution to the Kinetic Theory of Vaporisation.* **S. C. Bradford.** (Phil. Mag. 50. pp. 1147–1158, Nov., 1925.)—In a previous paper by the same author [Abstract 164 (1925)] an expression has been given for the vapour-pressure of a liquid in terms of molecular attraction, volume and motion, but the formula only applies to liquids of density 0·6 to 1·0. It is now shown that the vapour-pressure of liquids of any density can be expressed in the form $p = 81\cdot84\dfrac{T\lambda}{A\Phi}e^{-9\cdot656SvA^{2/3}/T\delta'\lambda^2}$, where T is the absolute temperature, λ the ratio of the total average velocity of the molecules in the liquid to that in a perfect gas, A the degree of association, Φ the co-volume, S the surface tension, v the volume of a gramme molecule, and $\delta' \times 10^{-8}$ the nearest distance of approach of the centres of the molecules in the liquid. Calculated values of λ for a number of practically unassociated liquids at about 25° C. show that λ is a function of density and temperature only. The vapour-pressures of eighteen liquids at widely differing temperatures have been calculated by means of the formula, and agree very closely with the observed values. A. W. L.

563. *A Treatment of Radiation-pressure and Gas-pressure as due to Inter-molecular Forces.* **J. Q. Stewart.** (Phys. Rev. 26. pp. 491–494, Oct., 1925.)—(1) The average repulsive force between two gas molecules associated with the emission of radiation by the one and its absorption by the other is calculated. Substitution of this value in the virial of Clausius justifies Eddington's proposition (in his theory of stellar constitution) that the total pressure is the sum of the gas-pressure and the radiation-pressure. (2) The Boyle-Gay Lussac law as a consequence of repulsive forces between molecules is exhibited by an analogous treatment of gas-pressure, which ascribes it to similar inter-molecular forces. (Of course, the hypothesis that such forces exist is merely a statistical fiction.)

AUTHOR.

564. *Emission of Radiation in Vacuum.* **H. Auer.** (Ann. d. Physik, 77. 7. pp. 658–684, Oct., 1925.)—The methods for the absolute determination of radiation fall into two classes: (1) The absorption method, (2) the emission method. The difficulties in the determination of the radiation constant σ are serious and arise chiefly from the use of blackening agents to increase the radiating and absorbing power of surfaces and from the uncertainty in the determination of the temperature of the radiating surface. Detailed description of the two forms of apparatus used, with sketches, are given. The temperatures in each case are measured with thermojunctions. The results obtained from the two methods of measurement are in good agreement, one method giving the absolute value of the emission and the other the time variation in the phenomena. The most characteristic results are given in a series of curves and tables. Metallic silver and copper give an increasing (positive effect) emission with decrease of the pressure of the vacuum, while silver thickly covered with petroleum black gives a decrease (negative effect) until the pressure reaches

10^{-1} mm. of Hg, after which, with decreasing pressure, there is an increase in emissive power. A new result was discovered in the decrease of the positive effect on long-continued evacuation, and a careful investigation showed that the value of the emission decreased asymptotically to its value in air. If the radiation is measured after long evacuation, a negative effect is obtained. The negative effect is explained by the known properties of a layer of lamp-black. The positive effect is much more difficult of explanation, and a lengthy examination of all possible sources of error in the experiments has shown that it cannot be explained in this way. The author concludes that the positive effect in a vacuum (*i.e.* a value greater than that for normal radiation) occurs when the difference of pressure between the interior of the metal and the surrounding gas is equalised by the radiating surface. T. B.

565. *Assemblies of Imperfect Gases by the Method of Partition Functions.* **R. H. Fowler.** (Cambridge Phil. Soc., Proc. 22. pp. 861–885, Nov., 1925.)—A mathematically simple treatment was recently given [see Abstract 713 (1923)] of the theorems of statistical mechanics for the usual assemblies of isolated or effectively isolated systems. The methods are now extended to assemblies, such as assemblies of imperfect gases, where the degree of isolation is no longer so high, in order to obtain the usual first approximations of the theory of van der Waals. In the first case investigated the free atoms and molecules are considered to act on one another with forces of short range. A simple account is given of the dissociative equilibrium of such imperfect gases, allowing for the effect of dissociation and recombination in altering the inter-molecular fields. It is found also that the methods can be naturally extended to deal also with the forces of long range, *i.e.* the inverse square law forces, gravitational and electrostatic. The range of validity of the combined use of Boltzmann's and Poisson's equations is carefully examined, with particular reference to the theory of strong electrolytes advanced by Debye and Hückel [Abstract 2328 (1923)] and Langmuir [Abstract 1650 (1923)]. It is concluded that the validity of this theory cannot be regarded as established except for "small" values of the ionic concentrations. T. B.

SOUND.

566. *The Relation between the Loudness of a Sound and its Physical Stimulus.* **J. C. Steinberg.** (Phys. Rev. 26. pp. 507–523, Oct., 1925.)—Experiments with many types of sounds have shown that the loudness of a sound is a function of its energy frequency spectrum and its level above the threshold of hearing, and that if this relationship be represented as follows:

$$L = \frac{10}{3}\log_{10}\left[\sum_{i=1}^{i=k}(W_iP_i)^{2/r}\right]^{r}$$

sounds whose calculated values L are equal will appear equally loud to the average normal ear. P_i is the r.m.s. pressure of the ith component of the sound wave. The weight and root factors, W and r respectively, are functions of the sensation level, which is synonymous with the term loudness as formerly used, and is defined as follows:

$$S = 10\log_{10}\left[\sum_1^k P_i^2 \Big/ \sum_1^k P_{0i}^2\right]$$

where P_{0i} is the r.m.s. pressure of the ith component when the complex sound is at the threshold of hearing. In case the components in a narrow band of frequencies Δn are not resolved their energy must be integrated to obtain the energy of the equivalent single component. The root factor r is inversely proportional to the ratio of the minimum perceptible increase in energy to the total energy. For intensities near the threshold, the weight factors are equal to the reciprocals of the minimum audible pressures. Curves are given showing the values of W for various frequencies at various sensation levels, also the values of r as a function of S. As the intensity is increased the weight factors give greater weight to the lower frequencies; hence, even though the amplitude of the sound wave be increased without distortion, the ear will perceive both an increase and a distortion. This effect is due to the non-linearity of the ear. [See also Abstract 175 (1925).] AUTHOR.

567. *Influence of a Branch Line upon Acoustic Transmission of a Conduit.* **G. W. Stewart.** (Phys. Rev. 26. pp. 688–690, Nov., 1925.)—The ratio of the energy of the incident acoustic energy transmitted with the branch present to that with the branch absent is found to be

$$[(Z_1^2 + Z_1\rho a/2S + Z_2^2) + (\rho a Z_2/2S)^2] \times [(Z_1 + \rho a/2S)^2 + Z_2^2]^{-2},$$

where the point impedance of the branch is $Z_1 + iZ_2$, ρ is the density of the fluid, a the velocity of sound and S the area of the conduit. *Application to the Helmholtz resonator and the cylindrical resonator.* The transmission ratios found are respectively,

$$\{1 + [4S^2(k/c - 1/kv)^2]^{-1}\}^{-1} \quad \text{and} \quad \{1 + (4S^2)^{-1}[k/c - (\sigma \tan kl)^{-1}]^{-2}\}^{-1}$$

where k is 2π/wave-length, c is conductivity of the orifice, and V and σ are respectively the volume and area of the branch. The theory can be

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applied to ascertain the transmission when the acoustic impedance of the side branch is known, or it may be used to measure the acoustic impedance of the side branch. AUTHOR.

568. *Sound-Changes Analysed by Records. I. Trumpet and Cornet.* **E. H. Barton** and **H. M. Browning.** (Phil. Mag. 50. pp. 957–967, Nov., 1925.)—The sound-changes concerned are those of loudness, pitch and quality. The equations of motion of the vibrations produced at the mouthpiece are written down with their solution. The initial vibrations consist of forced and free motions, both compound, the latter lasting for a very short time, as there is heavy damping. The apparatus used in recording the vibrations was a type of phonoscope similar to that described by Lapp [see Abstract 296 (1924)], a form of recorder which is, however, found to be highly selective. In the final arrangement, a Pointolite lamp was the source of light employed. Thirty-five records are given of vibrations caused by tuning-forks and by the cornet with single- double- and triple-tongueing, slurring, shakes and other changes. The records are considered to analyse the amplitude more delicately than the ear; the reverse is the case with regard to changes of pitch. G. E. A.

569. *Valve-maintained Tuning-forks without Condensers.* **T. G. Hodgkinson.** (Phys. Soc., Proc. 38. pp. 24–33; Disc., 33–34, Dec., 1925.)—A mathematical paper discussing the design of valve-maintained tuning-forks without condensers. It is shown that (1) the conductance of the valve grid decides the direction in which the electrode coils must be wound, and (2) it is advantageous, particularly in the case of low-frequency forks, to interpose transformers between the valve electrodes and the fork magnets. Actual numerical values are included in the paper. W. H. GE.

570. *Velocity of Sound in Mixtures of Gases.* **H. B. Dixon** and **G. Greenwood.** (Roy. Soc., Proc. 108. pp. 561–569, Dec. 1, 1925.)—The velocity of sound was measured in certain mixtures of gases by means of a double Kundt tube. Two glass tubes were fitted to the ends of a glass rod, the nodes of the glass rod being formed by rubber stoppers which closed the inner ends of the tubes and were situated at quarter of the length of the rod from each end. The middle half of the rod was excited by friction. The ratio of the wave-lengths gave the ratio of the velocities of sound in the two gases, that in air at 20° C. being taken as the standard. The cases dealt with were: (1) A mixture of H and O, with γ (ratio of specific heats) constant but density varying; (2) one of CO_2 and H with both γ and density variable; (3) a mixture of CO_2, H and air; (4) a mixture of CO and N, with constant γ and density and constant velocity of sound; (5) comparison of a single gas, NH_3, with a mixture of H and O of same density. The experimental results agreed with those derived from Laplace's formula, in which γ for the mixture is calculated from $(C_p a + C'_p b)/(C_v a + C'_v b)$, in which a and b are the volumes and C and C′ the specific heats of the two gases. [See also Abstract 1157 (1922).] G. E. A.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS AND ATMOSPHERIC ELECTRICITY.

571. *Properties of the Single Conductor. New Fundamental Relations.* **C. Hering.** (Am. I.E.E., J. 45. pp. 31–39, Jan., 1926.)—The properties of the single electrical conductor (one far removed from its return) are investigated in an endeavour to find whether a unit length of such a conductor, which embodies absolute ultimata, is suitable for a basic fundamental, on which deductions and a method of mathematical treatment could be based, to supplement (not to replace) the Maxwell system based on the "complete circuit," and to test the correctness of some of the postulates now in common use, based on the latter system. By several new, simple and direct proofs, based only on a few well-established and accepted relations, chiefly the internal stresses in a conductor, but excluding infinities, self-inductances, induction and any postulates, a constant is deduced for the energy stored by a current in such a unit length, which is claimed to be one of the most fundamental, basic constants in electrodynamics, from which many useful deductions can be made, some of which are given. This energy of the flowing current corresponds to the $mv^2/2$ energy of moving masses. It is explained why some of the results differ from those of our forefathers, who had added components to their resultant which already contains them. It is shown that with flux there is an analogy to the wattless ampere. It is claimed that the term self-inductance is ambiguous, being used in two different senses (inducing a counter e.m.f. and representing energy) which ought to be separated, as impedance is separated into a resistance and a reactance. It is claimed that some of these results could not have been obtained with the Maxwell complete circuit system, which rather leads away from them. AUTHOR.

572. *The Law of Periodic Energy.* **K. W. Wagner.** (Elek. Nachrichten. 2. pp. 376–392, Nov., 1925.)—Points out the importance of this law (Heaviside, "Electrical Papers," vol. i, p. 520, and vol. ii, p. 202) in the theoretical treatment of technical problems, and completes the observations of Heaviside on mechanical systems, electromagnetic fields and on complex electrical networks. It is shown how, as a special case of this law, the Heaviside formula $I = E/Z_0 + E\Sigma\epsilon^{pt}/pz'_1$ can be deduced. E. T. A. R.

573. *The Heaviside Operational Calculus.* **H. Salinger.** (Elek. Nachrichten. 2. pp. 365–376, Nov., 1925. From the Telegraphentechn. Reichsamt.)—Shows how the symbolic or operator method simplifies the solution of problems involving the propagation of electric currents along lines. Complete solutions are given for a line having (1) resistance and capacity only, and (2) resistance, capacity, inductance and leakage. E. T. A. R.

574. *Influence of Surrounding Medium on Frictional Electricity.* **J. H. Jones.** (Phil. Mag. 50. pp. 1160–1177, Nov., 1925.)—The rubber was mounted on a disc carried by the shaft of a motor and the specimen held in contact. Both disc and specimen were enclosed in an air-tight vessel so that the effect of various gases and liquids could be observed. A modified quadrant electrometer with slate needle was used to measure the potential. Better results were obtained with a conducting disc than with an insulator. If a metal is rubbed by silk in air and the potential is low, the introduction of coal-gas, H_2, or CO_2 causes it to rise, and *vice versa*. The introduction of SO_2 causes the potential to rise, whether it was high or low in air. The potential of the metal is increased by the presence of a liquid of appreciable conductivity. The effect of a liquid insulator increases with rise of temperature up to a certain point, when the insulation appears to break down. The temperature of the rubbed metal rises almost in proportion to its potential. F. S.

575. *Thunderstorm Changes of the Electric Field and their Propagation to Great Distances.* **P. Lejay.** (Comptes Rendus, 181. pp. 678–679, Nov. 9, 1925.)—The components of the electromagnetic disturbance at any distance from the discharge are stated, using the theory of images and assuming the earth a perfect conductor. Theory agrees with results obtained at the Pic du Midi Observatory regarding the rapid changes of electrical potential gradient. At 30 km. from the storm it may exceed 400 volts/metre, and at 100 km. more than 1 volt/metre. Changes at these distances are also noticed for non-luminous discharges. The field decrease agrees approximately with the inverse cube of the distance. It is also shown that these discharges may affect a wire or frame aerial differently by the action of the electric and magnetic vectors. R. S. R.

576. *Thunderstorm Changes of the Electric Field and their Propagation to Great Distances.* **P. Lejay.** (Comptes Rendus, 181. pp. 875–877, Nov. 30, 1925.)—The rapid oscillations in minor thunderstorms cannot be analysed by the kathode oscillograph. The author, to measure these oscillations, connects his aerial through a condenser to earth, the capacities of aerial and condenser being equal. The condenser is shunted by a high resistance R. If R has its usual value of 10 megohms the current in it delays the measurement of the rapid changes of potential in the aerial, but by reducing R to 10^5 or 10^4 ohms true values are obtained for these atmospherics. Radiogoniometric measurements give the positions of the atmospherics to within several hundred km. The differences between theory and experiment arise from the earth not being a perfect conductor and consequently the theory of electric images not being quite applicable. [See preceding Abstract.] R. S. R.

577. *Electrometer Apparatus for the Study of the Electric Field in the Atmosphere.* **E. Salles.** (Comptes Rendus, 181. pp. 802–803, Nov. 23, 1925.)—To determine the potential of the air below 1 metre the author uses a leaf electrometer combined with a small plate condenser, the deflection of the leaves being magnified when the upper plate of the condenser is rotated away from the lower plate. With this arrangement voltages in a field of 50 volts or less can be determined, and the author considers the method applicable for study of the electric field near the ground and the determination of the coefficient of reduction to the ground. It is also useful on board ship. R. S. R.

DISCHARGE AND OSCILLATIONS.

578. *Designation of Different Varieties of Electric Discharges through Gas and Dielectrics.* **Jouaust.** (Soc. Franç. Élect., Bull. 5. pp. 927–930, Sept., 1925.)—The seeming want of accord in the designation of electric discharges is discussed, and the author endeavours to draw the attention of physicists to the difficulties which surround correct designation. [See also A. Dauvillier, Abstract 354 (1926).] A. E. G.

579. *New Method of Demonstrating the Phenomena in Discharge Vessels.* **A. Katsch.** (Zeits. techn. Physik, 6. 11. pp. 595–599, 1925.)—Excitation phenomena at very low pressures (10^{-4} to 10^{-5} *mm*Hg) are here used as indicators of electron movement in highly evacuated electron tubes. The nature of these phenomena is investigated through a very wide range of potential at the electrodes, and three kinds of excitation are explained as follows: excitation through electrons, excitation through negative ions, excitation through positive ions. The paper is illustrated with ten photographs. A. E. G.

580. *Change of Wave-lengths in the Condensed Discharge.* **M. Fukuda.** (Inst. Phys. and Chem. Research, Tôkyô, Sci. Papers, No. 37. pp. 183–192, July, 1925.)—The shift of certain spectral lines due to zinc, cadmium, and mercury were observed in a fused silica Geissler tube, through which was passed a condensed discharge. Variations were observed when the capacity was altered and when the spark in series with the tube was varied in length. The latter variation was found more effective, and was investigated quantitatively. Certain spark lines came out with greater intensity as the gap in series was increased. Most of the lines which shifted were sharp-series lines, and they moved to the red. Some of the diffuse lines moved to the red, a few to the violet. It was concluded that the shifting of certain lines is due to the inter-molecular field due to the crowding of ions and electrons in the capillary. A. C. M.

581. *A Certain Type of Air Discharge-Tube at the Critical Resistance for Flashing.* **J. Taylor** and **L. A. Sayce.** (Phil. Mag. 50. pp. 916–937, Nov., 1925.)—This paper deals with a continuation of work on the flashing of air-electric discharge-tubes in which the electrodes are near together and there is no positive column. A previously described method is used for the measurement of both the apparent lower and upper critical voltages (extinction and sparking potentials respectively) V_B and V_C, when the tube is flashing at the critical resistance just before the conditions of steady discharge obtain. A *résumé* of the previous work on the variation of the critical voltages for the "single flash" is given. The variations of the critical constants for the tube under conditions of continuous flashing are discussed in a general manner, and the following general theoretical relations are put forward:

$$V_C = v_c + 1/C\left[\int_0^{t_1}\theta(C, V) \, . \, dt - \int_0^{t_1}(E - V)/R \, . \, dt\right]$$

where v_c is the normal upper critical voltage for the steady discharge, C is the value in microfarads of the capacity across the tube terminals, t_1 is the time required to establish the glow-discharge, and $\theta(C, V)$ is the current voltage function through the tube at any instant during this

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time, E the charging voltage, and R the circuit resistance, and V is the voltage across the tube terminals at any instant t during the interval 0 to t_1.

$$V_B = V'_b - 1/C\left[\int_0^t f(C, V)\,.\,dt - \int_0^t (E - V)/R\,.\,dt\right]$$

where V'_b is the value of the extinction voltage at which the glow-discharge just ceases when the tube is flashing at the critical resistance, t the time required for the clearing up of the space-charge, etc., after the glow-discharge has ceased, $f(C, V)$ the current-voltage function during this time. The critical resistance for flashing is further considered, the relation being of exactly similar form to that previously derived. $R_c = (E - V'_b)/\psi(V'_b)$ where R_c is the critical resistance below which no flashes can be obtained for the charging voltage E, and $\psi(V'_b)$ is the current voltage function for the discharge-tube at the extinction voltage V'_b. The current at the critical resistance, when the conditions have become steady and there are no flashes, is given by the relation $i_c = \delta E/\delta R_c\,.\,(1 - \beta)$ where $\beta = (V_b - V'_b)/(E - V'_b)$. It is shown that the graphs giving the relation between the mean current i_e, when the tube is flashing at the critical resistance, and the charging voltage E, will approach the lines $i_c = \delta E/\delta R_c$ and $E = V_C$ asymptotically. The experimental section deals with the examination of these relations over a range of pressures, and the general agreement between the theoretical and practical results is found to be good. An anomaly arises in the value of the intercept $I(V'_b)$ on the axis of the voltage of the E, R_c graphs, and this is discussed for different values of the capacity and pressure of the air in the discharge-tube. The variation of the apparent upper and lower critical voltages for different capacities across the tube and different pressures is discussed. [See also Abstracts 1454 and 1455 (1925).] A. E. G.

582. *Discharge of Electricity between Equipotential Plates.* **M. E. Hufford.** (Phil. Mag. 50. pp. 1197–1214, Dec., 1925.)—J. J. Thomson has described [see Abstract 1921 (1909)] conditions under which a beam of canal rays in a low-pressure discharge-tube produces behind the kathode a fully developed discharge like that between the anode and kathode. In the present paper investigation is made of the discharge of electricity between parallel and equipotential plates which form the kathode of a discharge-tube. Important phenomena connected with the discharge are the presence of a bright bead passing through the hole in the plate nearest the anode and a glow which fills the volume between the plates. The glow region has a dark space next to the metal surface. The length of the dark space depends upon the kind of gas, the gas-pressure and the material of the kathode. Investigation with a magnet shows that electrons are evolved from the metal surface between the kathode plates. At low pressures a kathode stream passes through the opening towards the anode. The presence of electrons and the glow indicate an ionised state of the gas and the neutralisation of the canal rays between the plates. Spectroscopic examination of the bead and glow reveals the intense lines characteristic of the gas with the bright lines of Hg superimposed. The maximum and minimum pressures at which the bead and glow can be maintained in different gases are determined. Experiments are made to show the relation of total voltage, total current and current flowing from the back plate of the kathode. Curves show these relations at different pressures. Investigations to show the dependence of pressure-range and pressure of the bead and glow are made. Potentials at points between the kathode plates are measured by means of a probe in air, oxygen coal-gas, hydrogen coal-gas, coal-gas, and the simple gases hydrogen, oxygen and helium. Graphs show these potentials at different pressures. Graphs are also given which show the change in potential of the glow with change in pressure. It is shown that the range of pressure at which the bead and glow are present in different gases varies widely. Experiments are made to determine the potentials in the glow with helium, using copper electrodes. These potentials are shown to be higher than those obtained with aluminium. Similar experiments are made with air, using gold as the kathode. It is found that when the glass walls become coated with sputtered metal the bead cannot be produced. Measurements show higher potentials in the glow under these conditions. Graphs are given which show the change in potential in the glow with a reduction of pressure in oxygen and hydrogen when the bead is not present. Conditions are discussed under which oxygen gives striations between the equipotential plates. A. E. G.

583. *Flashing of Certain Types of Argon-Nitrogen Discharge-Tubes.* **W. Clarkson.** (Phys. Soc., Proc. 38. pp. 10–14 ; Disc., 15, Dec., 1925.)—This paper is a continuation of previous work [see Abstracts 1454 and 1455 (1925)]. On flashing phenomena in discharge-tubes, in which, as the electrodes are only 1 or 2 mm. apart, the positive column is absent, and only the negative glow, with an occasional anode glow, is in evidence. In the present work an account is given of investigations on the flashing of discharge-tubes having various types of electrodes, and in which the filling gas, a mixture of argon and nitrogen, had a wide pressure range. It is shown that the observations are in general agreement with those obtained previously with neon and air discharge-tubes, minor differences between tubes are discussed, and it is found that at higher pressures the discharge is no longer of the "glow" type, but takes place between definite points on the electrodes. A. E. G.

584. *Generation of Oscillations in a Discharge-Tube.* **R. E. Clay.** (Phil. Mag. 50. pp. 985–997, Nov., 1925.)—The tubes used in the experiments described had for anode the flat tip of a piece of aluminium wire about 2 mm. diameter and enclosed in a glass tube fitting over it closely. The tip of the wire was situated at the centre of a bulb about 5 cm. diameter whose inner surface was silvered, the silver coating forming the kathode. Current for the discharge was obtained from a battery of 500 small accumulators ; it was adjusted by passing it through the filament-anode space of an R-valve whose filament current was varied. When the current was about 1 milliamp. oscillations were generated. These were examined by means of a kathode-ray oscillograph. A theory is given of the action, which appears to be identical with that of the neon lamp. A second type of oscillation was obtained with weaker current. A. W.

585. *Constricted Mercury Arc.* **G. S. Forbes** and **G. R. Harrison.** (Am. Chem. Soc., J. 47. pp. 2449–2454, Oct., 1925.)—Deals with the intensity, steadiness, economy, convenience, efficiency and life of the water-cooled, constricted-column, mercury-vapour lamp run at atmospheric pressure. The constricted arc will furnish, per sq. mm. of exit slit of a monochromator, energy flux up to thirty times that available from a commercial lamp run at normal rating. For quantitative work the radiations of the constricted arc must be followed by a thermopile and the energy integrated graphically. The deterioration is 50 % for the first hour at λ254 and 5 amps., but this rate falls off greatly with increase of time and wave-length and with decrease of current. Since this is true for all mercury lamps, it follows that the shorter the wave-length used, the more advantageous is the ease of renewal of the open type. The results are compared with those for the standard vertical-sealed-electrode commercial lamp. W. H. Ge.

586. *Theoretical Probability Considerations on the Time of Lag with Spark Discharges.* **W. Braunbek.** (Ann. d. Physik, 78. 4. pp. 423–424, Dec. 1, 1925.)—This paper consists of criticisms of the work of J. Dejmek [see Abstract 147 (1926)], in which he states that between the theoretically derived distribution function of lag times with spark discharges of v. Laue and the measured distribution by K. Zuber there is want of agreement. He bases the above conclusion on the assumption that, in the equation $ln\,\overset{*}{\eta}_t = -\beta p(t - t_0)$ derived by v. Laue, β and p are probability numbers which cannot exceed 1, while Zuber found for the product βp the value 1·86. It is here contended that this assumption is incorrect, and it is shown that the product βp can have such a value as 1·86.
A. E. G.

587. *Electron Paths.* **A. Güntherschulze.** (Zeits. f. Physik, 34. 9. pp. 639–644, 1925.)—A simple method is described for calculating the electron paths in the case where the kathode emitting the electrons consists of a very thin wire and where the field is either a homogeneous or a simple non-homogeneous one. For details of the method the original paper must be consulted. A. W.

588. *Normal Kathode Fall in Krypton and Xenon.* **A. Güntherschulze.** (Zeits. f. Physik, 34. 8. pp. 549–552, 1925.)—Measurements were made of the kathode fall of potential and of the normal current density at 1 mm. pressure for krypton (containing 5 % xenon) and xenon (containing 7 % krypton). The apparatus was washed out repeatedly with pure neon for several days before the introduction of the gases to be tested. Iron kathodes were used. The following results were obtained: Normal kathode fall in krypton, 215 volts; in xenon, 306 volts: normal current density at 1 mm. pressure in krypton, $4 \cdot 3 \times 10^{-5}$ amps.; in xenon, $1 \cdot 6 \times 10^{-5}$ amps. Evidence was also obtained in favour of the assumption that the ionising power of the kations at the kathode decrease with increasing atomic weight of the kations. A. W.

589. *Flames of Atomic Hydrogen.* **I. Langmuir.** (Science, 62. pp. 463–464, Nov. 20, 1925.)—In connection with R. W. Wood's work on atomic hydrogen and the Balmer series spectrum [Abstract 53 (1923)] the author suggested that the high temperatures obtained were due to a high concentration of atomic hydrogen which could accumulate in the tube because of the effect of water-vapour in poisoning the catalytic activity of dry glass surfaces that otherwise destroyed the atomic hydrogen. Applications of this action were tried by passing powerful electric arcs between tungsten electrodes in hydrogen at atmospheric pressure. The arc obtained was of a beautiful red colour, of small diameter and bowed out into a fan shape by its own magnetic field. Iron rods, 2 to 3 mm. in diameter, melted easily just above the arc. By directing a jet of hydrogen from a small tube into the arc an intensely hot flame could be formed, in which molybdenum melted with ease and tungsten also could be melted; quartz, on the other hand, could be melted only with difficulty, indicating that the catalytic action of the metals played an important part in the rapidity with which they could be melted. The technical application of this process to the melting of metals and to welding operations is indicated and further details promised. C. O. B.

590. *Probability of Ionisation of Gas Molecules by Electron Impacts.* **K. T. Compton** and **C. C. van Voorhis.** (Phys. Rev. 26. pp. 436–453, Oct., 1925.)—*Ionisation in Various Gases by Electrons of Energy* 0–325 *Volts.*—Electrons from a hot filament were projected through an ionisation chamber B containing gas at low pressure (0·001 to 0·005 mm.) and into a trap. Positive ions produced in B were collected on fine wires arranged in the form of a squirrel-cage C and maintained at a potential lower than B by an amount V_r. Corrections were made for the facts (1) that the wires C lowered the potential at the centre of B and hence retarded the electrons passing through B by a maximum amount of $0·4 \times V_r$, and (2) that if V_r were numerically less in value than the accelerating potential V_a, some primary electrons reached C. The pressures were measured with a McLeod gauge to 1 %, and were corrected for the heating effect of the filament, which was determined by using the apparatus as an ionisation manometer to be about 26°. The resulting curves for N, the number of ions per cm. path produced by an electron moving through a gas at 1 mm. pressure, are believed correct within a few per cent. In agreement with previous results of Hughes and Klein and others, the curves each rise to a maximum. The maximum values found and the corresponding voltages are as follows:

	H_2.	He.	Ne.	A.	N_2.	Hg.	HCl.
$N_{max.}$	3·55	1·65	3·2	10·33	9·96	19·44	17·3
$V_{max.}$	145	210	340	140	175	135	130
$P_{max.}$	0·29	0·209	0·254	0·466	0·423	0·239	0·558

The values for $P_{max.}$, the corresponding probability that a collision will result in the ionisation of the hit molecule, were computed from $N_{max.}$ assuming the kinetic theory values for electronic mean free paths. These results are compared with previous experimental values. Ionisation was found to begin at the ionising potential in each case, except that with N_2 weak ionisation was observed at 10 volts. This may possibly be associated with the presence of traces of active nitrogen. AUTHORS.

591. *Post-Arc Conductivity and Metastable Helium.* **C. Eckart.** (Phys. Rev. 26. pp. 454–464, Oct., 1925.)—A study has been made of the abnormal conductivity which Kannenstine [see Abstract 1537 (1924)] found persisted for 0·007 sec. after the arc was extinguished. The results prove that the residual conductivity is due to positive ions and not to metastable excited helium atoms, as suggested by Kannenstine. By means of adjustable commutators, the arc tube was connected first to a battery which caused an intense arc (period A), then after a brief interval (period B) to a source of voltage V_e through a micro-ammeter (period C). As V_e was increased the micro-ammeter showed a small negative current (positive ion) to 1·2 volts, then a regularly increasing positive current reaching saturation at 8 volts. The logarithm of the saturation current was a linear function of the length of period B for $V_e = -15$ volts and for $V_e = -26$ volts, the current decreasing to one-tenth in from 0·004 to 0·007 sec. (Similar observations in mercury gave a constant of 0·01 to 0·02 sec.) Observations with a Braun tube oscillograph gave direct additional evidence that after the arc ceased, the current decreased exponentially with time, independent of the length of the interval B. An attempt to sweep the positive ions away by applying a high negative voltage during B failed. Spectrographic observations made with a rotating slit attached to the commutator showed that no light was emitted during period C, even when the helium had been so carefully purified that the bands were distinctly visible in the spectrum of the arc. While there is good evidence that metastable helium atoms persist for a longer time than ordinary excited atoms, the only evidence for a life of the order 1/140 sec. rests on Kannenstine's interpretation of the persistent post-arc conductivity, and the experiments in this paper prove his interpretation to be unjustified. AUTHOR.

592. *Ionisation of Hydrogen by Slow Electrons.* **H. Kallmann** and **M. Bredig.** (Zeits. f. Physik, 34. 10. pp. 736–750, 1925.)—By means of the magnetic deflection method an investigation was made of the ions generated in hydrogen by electrons with velocities corresponding to voltages of from 15 to 30 volts. Four maxima were found: an ion $H_{\frac{1}{2}}^+$ with the apparent mass M/2, and also H_1^+, H_2^+ and H_3^+ ions. The intensity of H_3^+ was found to be greatest at a pressure of 0·01 mm. of mercury, H_2^+ having then an intensity about ½ of H_3^+ and the intensity of H_1^+ being still less. The intensity of $H_{\frac{1}{2}}^+$ is not directly measurable. The nature of the ions was determined by measurements of the ionisation potential and by measurements of the dependence on the gas-pressure. The ionisation potentials of H_1^+, H_2^+ and H_3^+ lie very close together; that of $H_{\frac{1}{2}}^+$ seems, however, to be considerably higher. From the dependence on pressure it was found that the intensities of H_1^+ and H_3^+ relative to that of H_2^+ decrease with the pressure. H_2^+ is certainly a primary ion, and it appears very probable that H_1^+ and H_3^+ are secondary ions derived from H_2^+. A. W.

593. *Predicted Ionisation Potentials of Niton and Hydrofluoric Acid.* **G. Glockler.** (Phil. Mag. 50. pp. 997–1001, Nov., 1925.)—Turner has predicted the ionisation potential of niton to be 27·5 ± 1·5 volts and that of hydrofluoric acid to be 17·9 ± 0·5 volts, his predictions being based on an empirical rule connecting the quantum-defect with atomic number [Abstract 28 (1925)]. Arguments here put forward tend to discredit Turner's values. From the diffusion coefficient of niton in air the kinetic-theory radius of niton has been calculated to be 2·8 ± 0·25 Å.U., and by interpolation from Eve's rule the value for the neon radius is estimated to be 1·29 Å.U. Methods of extrapolation lead to values of 10 and 15 volts respectively for the ionisation potentials of niton and hydrofluoric acid. A. W.

594. *The Mobility of Argon and Hydrogen Ions in Air.* **H. A. Erikson.** (Phys. Rev. 26. pp. 465–468, Oct. 1925.)—The apparatus and method are the same as previously used to measure the mobilities of air, CO_2 and other ions in air, the freshly formed ions being driven across a stream of air by means of an electric field. Two positive ions and one negative ion were found in both argon and hydrogen as in the case of air. The initial positive hydrogen ion was found to transform into the second, and this is doubtless also true in the case of argon, though it was not proved. The mobilities are also the same as obtained for the air ions except in the case of the negative hydrogen ion, which has a higher mobility than the negative air ion. It is thus found that the following monomolecular ions all have the same mobility in air at normal pressure: monatomic A, initial + and −; diatomic air, initial + and −; diatomic H_2, initial +; triatomic CO_2, initial + and −. Thus the mobility of these ions seems to be independent of the masses. The only exception so far found is the negative H_2 ion. AUTHOR.

595. *The Regulation of the Positive Emission in a New Metallic Tube with a Heated Anode.* **M. Morand.** (Comptes Rendus, 181. pp. 544–545, Oct. 26, 1925.)—A continuation of previous work [Abstract 1876 (1924)]. Owing to difficulties with glass tubes a metallic tube has been constructed allowing a voltage up to 100,000 volts to be used and other improvements introduced. The variation in the emission of positive rays with variation of potential has been studied. This emission depends on the temperature of the anode and the nature of the salts on it. The emission is zero until a certain voltage V_0 is reached, V_0 depending on the form of the anode, distance to the kathode and temperature. It then increases according to a law represented by $i = k(V-V_0)^{3/2}$. Eventually the emission increases more rapidly, and finally when a certain value is reached the tube functions at constant voltage V_1. V_0 and V_1 vary between 15,000 and 80,000 volts. These results may be explained as follows: Until V_0 is reached the positive ions cannot emerge, but are torn out above this voltage. The halogen liberated gives its charge to the anode and is then neutral, but the space charge prevents the increase of emission. This corresponds to the 3/2 power law. If the halogen is ionised, the positive ions are removed, the negative ones reduce the space charge, and an arc at constant voltage is produced. W. V. M.

596. *Velocity Loss of Medium Velocity Kathode-Rays in Metals.* **A. Becker.** (Ann. d. Physik, 78. 3. pp. 209–227, Nov., 1925.)—The apparatus used is described and illustrated diagrammatically, and results are shown in both graphical and tabular form. The loss of velocity of kathode-rays of medium velocity is determined by magnetic deflection and absorption measurements, and an attempt is made to find a limiting thickness. The deflection experiments are carried out up to a thickness of 0·028 mm. aluminium. A better insight into the nature of the loss of velocity is obtained by micro-photometric measurements of the photographs in the magnetic field. The absorption measurements show a strong rise of the absorption coefficient with increasing layer corresponding to the loss of velocity in the metal. For equal masses the loss of velocity in aluminium and platinum are nearly equal. The same applies also to absorption. With gold there is clearly a smaller loss than with Al or Pt. The absolute values obtained for the velocity loss in aluminium are somewhat smaller than those found by v. Baeyer, and approximate, with decreasing velocity, to those given by Lenard. A. E. G.

597. *Velocity of Secondary Kathode-Rays.* **A. Becker.** (Ann. d. Physik, 78. 3. pp. 228–252, Nov., 1925.)—The velocity distribution of escaping electrons from a blackened metal surface which is vertically radiated by homogeneous kathode-rays is measured in central electrical fields. The velocity of the exciting primary rays is varied between 24 and 1075 volts. With a blackened surface the secondary rays generally preponderate over the back-turning (back diffusing or reflected) primary electrons of smaller velocity. The velocity distribution of the investigated secondary rays is identical with that of δ-rays. The probable initial velocity and also the absolute value of all secondary velocities is, in the region tested, independent of the velocity of the primary rays. The observed most probable velocity of the secondary rays amounts to about 2 volts; in this also they are idential with δ-rays. [See also Abstract 3046 (1924).] A. E. G.

598. *Back Diffusion Reflection and Secondary Ray Excitation of Slow Kathode-Rays.* **A. Becker.** (Ann. d. Physik, 78. 3. pp. 253–276, Nov., 1925.)—When the surface of a solid is struck by kathode-rays two kinds of electrons issue from it, known as secondary and back-turning. An arrangement is here described by means of which direct measurement can be made of the initial velocities of electrons issuing from a substance in a certain direction when that substance is radiated by slow kathode-rays (10 to 1000 volts). Experiments in which pure and blackened platinum is the substance radiated are described. The following are some of the results obtained. The distribution curve of velocities shows three distinct portions, the first, in which there is a very quick fall, corresponding essentially to secondary radiation, the second, in which the fall is more gradual, and the third showing a quick fall; the two latter both belong to the back-turning primary electrons. With small primary velocities the last part of the curve is very marked, corresponding to the presence of such primary electrons which leave the radiated body with very little loss of velocity (1–2 volts). When primary velocities are under about 12 volts apparently all escaping electrons are reflected, but the proportion of these quickly decreases with increasing primary velocity. It is concluded that the velocity distribution of the secondary rays does not appear to depend to any marked degree on the direction of the emission. A full description of the apparatus used is given, and the results are shown in both graphical and tabular form. A. E. G.

599. *An Electron-Tube Generator of Short Electric Waves.* **M. T. Grechowa.** (Zeits. f. Physik, 35. 1. pp. 50–58, 1925.)—An apparatus is described (with diagram) consisting in the main of two electron-tubes, the grids and anodes of which are connected by a variable wire system. By means of this arrangement it is found possible to obtain a generator of undamped oscillations of 50 cm. wave-length. If the anode tension is maintained at any certain value between − 5 and + 14 volts, both grids assume a tension of + 50 to + 160 volts. It is found that the wave-length depends upon many factors, including the heating current, grid tension, anode tension and the ratio of the anode diameter to the grid diameter. As this is the case, it becomes possible to generate any given wave-length in the region 50 cm. to 1 m. The alteration of the wave-length through the alteration of grid tension is not in accord with the formula of Barkhausen and Kurz [see Abstract 908 (1920)] nor with that of Scheibe, which shows that the oscillations obtained by this means are of a complicated nature and depend in a high degree on the dimensions of the anode oscillation circuits. A. E. G.

600. *Heaviside Layer.* **G. J. Elias.** (Elek. Nachrichten. 2. pp. 351–358, Nov., 1925.)—In this paper the author discusses the present position of our knowledge of the Heaviside layer in the light of recent researches on the propagation of electric waves, the aurora, etc. A. W.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

601. *Simultaneous Measurement of High-frequency and Direct-current Resistance of Fine Wires at Various Temperatures.* **J. D. Stranathan.** (Phys. Rev. 26. pp. 500–506, Oct., 1925.)—Simultaneous measurements of h.f. ($3 \cdot 12 \times 10^5$ cycles) resistance and d.c. resistance of platinum wires 0·0513 mm. in diameter were made at temperatures ranging from about 20° to around 750° C. Such measurements were made by sending both a high-frequency alternating current and a direct current through the wire and making simultaneous and independent measurements of alternating current, alternating potential drop, direct current and direct potential drop. These measurements were made independent through proper use of choke coils and blocking condensers. For wires of this size no account need be taken of inductive reactance to a frequency of 10^6 cycles. The temperature of the wire was governed by the magnitudes of the currents through it. Such measurements were made on wires in air, in vacuum and in H_2 at atmospheric pressure. In all cases the h.f. resistance agreed with the d.c. resistance at all temperatures within the limits of error, ± 1 %. The absorption of H_2 by the platinum affected both resistances equally at the frequency used. AUTHOR.

602. *Thermoelectric Effect in Single Crystal Zinc Wires.* **E. G. Linder.** (Phys. Rev. 26. pp. 486–490, Oct., 1925.)—The crystals were prepared by the Czochralski method, drawing each in the form of a wire through a 2-mm. hole in a mica disc which floated on the surface of the zinc, kept just a few degrees above its melting-point. After slight amalgamation, the crystals split readily along the basal plane, normal to the vertical axis. The angle between this axis and the axis of the wire is the orientation θ of the crystal. Each end of a crystal was sealed with cadmium into a copper block, one of which was kept at 0° C., the other at a temperature T, varied up to 290° C. The ratio of thermo-e.m.f. E to T is found not to be a linear function of T, but to increase with T more rapidly. The curves for the higher values of θ lie above those for lower values, so that with a circuit of differently oriented crystals the e.m.f. is directed, at the hot junction, from the crystal of higher to that of lower orientation. For wires with $\theta = 14°$ and $\theta = 86 \cdot 5°$, the e.m.f. with $T = 250°$ would be $6 \cdot 50 \times 10^{-4}$ volts. The neutral temperature ($dE/dT = 0$) decreases from about 500° for $\theta = 14°$ to 40° for $\theta = 86 \cdot 5°$. AUTHOR.

603. *Thermoelectric Power and the Hall Coefficient.* **C. W. Heaps.** (Phil. Mag. 50. pp. 1001–1009, Nov., 1925.)—In 1896 it was pointed out by Beattie that the Hall-effects and the thermoelectric powers of a large number of metals have corresponding signs. Beattie also showed that the variation with temperature of these two phenomena is strikingly similar in the case of bismuth, and Wold [see Abstract 612 (1916)] has found the same similarity in the curves for tellurium. Trabacchi has pointed out that the Hall-effect and the thermoelectric height in tellurium-bismuth alloys vary in nearly parallel fashion as the composition of the alloy is changed. There seems to be abundant experimental evidence of a close relationship of some kind between these two phenomena—a relationship which is to be expected from the standpoint of the free electron theory of metals. This theory gives for the coefficient of the Hall-effect $R = A/Ne$, where A is a constant, e the charge on an electron, and N the concentration of free electrons in the metal. For the thermoelectric power of one metal with respect to another the theory gives $E = k/e \, . \log N_1/N_2$, where N_1/N_2 is the ratio of electron concentrations in the respective metals and k is a constant, usually the gas constant for one molecule. These equations show that any factor changing the value of N for a given metal will produce corresponding changes in E and R. Temperature changes presumably change N, and the effect on E and R has been noted. It is the purpose of the present paper to show the effect on E and R of changing the strength of the magnetic field in which the specimen is placed. Suppose a thermoelectric circuit made up of two metals, one of which, like copper, is not affected thermoelectrically by a magnetic field. Let N_1 be the constant electron concentration in this latter metal, N_0 the concentration in the other metal when no magnetic field acts, and N_H the concentration in a field H. Then in zero magnetic field the thermoelectric power $E_0 = k/e \, . \log N_0/N_1$, which in a field H becomes $E_H = k/e \, . \log N_H/N_1$. Thus $E_H - E_0 = k/e \, . \log N_H/N_0$. Let R be the value approached by the Hall coefficient as the magnetic field approaches zero, and let R_H be its value in a field H. Then $N_H/N_0 = R_0/R_H$, thus $E_H - E_0 = k/e \, . \log R_0/R_H$. According to this equation, if the Hall coefficient of a metal changes as the magnetic field increases there should be a change in the thermoelectric power of the metal when it is placed in a magnetic field. The apparatus for measuring thermoelectric forces is described and the experimental results obtained are given in both graphical and tabular form. The conclusion is drawn that it seems probable the phenomena of ferromagnetism introduce complications which are not contemplated in the simple theory here given. This theory, however, may be considered as at least a step in the right direction when applied to non-ferromagnetic substances. A. E. G.

604. *The Theory of the Single-fibre Electroscope, and a New Design of the Instrument.* **W. F. G. Swann.** (Optical Soc. America, J. and Rev. Sci. Inst. 11. pp. 375–391, Oct., 1925. Paper read before the Am. Phys. Soc., April, 1924.)—If k is the mechanical restoring force per unit displacement of the fibre, the actual restoring force per unit displacement may readily be shown to be $k - CX^2$, where C is the capacity of the fibre and X the field between the plates. The deflecting force due to a change of potential δV in the fibre is $CX\delta V$, so that the sensitivity S is $S = CX/(k - CX^2)$. If k is less than CX^2 the instrument is unstable, and the fibre flies to either one plate or the other. The sensitivity becomes very large if $k - CX^2$ is small; and in obtaining high sensitivity from the instrument, this condition is usually satisfied, even though the fact may not be realised. It is a bad condition, since it results in large variations in S for small variations in either k or X. If we desire to restrict ourselves to the case $k - CX^2 = k/2$, so that we draw upon the term CX^2 to the extent of no more than doubling the sensitivity which we should obtain in its absence, S reduces to the very simple expression $S = 1/X$, which, under a magnification of 100, gives a deflection of 1000 mm. per volt for a field of 1 volt per cm. between the plates. High sensitivity consistent with great constancy necessitates a small field between the plates and correspondingly small value of k. An instrument meeting the required conditions is described. As an illustration of the performance of the electroscope one experiment gave, with a magnification of 600 and a potential difference of 6 volts between plates, a sensitivity of 3500 eyepiece divisions per volt and a period so short that the fibre assumed a steady reading in less than ½ second after application of the potential. Moreover, the linearity of the calibration curve over the whole range of the eyepiece scale was so perfect that departures from linearity could not be observed within the limits of accuracy of the readings. AUTHOR.

605. *A New Capillary Electrometer and the Relation between the Mercury Displacements and the Radius of the Tube.* **C. E. Bennett.** (Optical Soc. America, J. and Rev. Sci. Inst. 11. pp. 411–417, Oct., 1925.)—The ordinary Lippmann type of capillary electrometer consists of a single fine tube in which the rise of mercury depends upon the impressed voltage for small voltages up to 1 volt. The new capillary electrometer here discussed is an inverted **U**-tube device whereby direct readings of the pressure difference between the two mercury levels can be made, thus obviating the necessity for assuming that the large surface in the reservoir is unchanged. Its advantages lie in its comparative simplicity, its sensitivity (1 volt corresponding to 1·5 cm. deflection compared with 0·5 cm. for an ordinary Lippmann-type instrument) and its direct readings. The instrument is a result of an investigation into the laws of capillary electrometric phenomena. Lippmann's voltage-height relation is verified in an independent manner and extended to tubes of different radii. A new relationship is found, that between the rise of the mercury and the radius of the tube. A simple curve represents this result, but a simple analytic expression does not exist due to the extreme complexity of the phenomenon, as theory shows. AUTHOR.

606. *Measurement of Peak Potentials.* **F. Bedeau** and **P. David.** (Onde Élec. 4. pp. 462–469, Nov., 1925.)—A description is given of an application of triodes to measure the maximum p.d. at the terminals of a circuit carrying alternating current. The circuit is introduced into the grid-filament circuit of a triode with a battery and potentiometer which is adjusted so as to obtain zero anode current. In order to make the method sensitive a second triode is coupled to the first, resistance coupling being used. The selection of suitable triodes is discussed, and tests are described of the method which can be used to determine both the positive and negative maxima of the alternating p.d. at the circuit terminals. A. W.

607. *The Sensitivity of the Paschen Galvanometer. I. The Moving System.* **H. A. Daynes.** (Journ. Sci. Instruments, 3. pp. 7–12, Oct., 1925.)—To secure the highest possible figure of merit the design has to be modified so that full advantage may be taken of the properties of cobalt steel. The paper investigates mathematically the optimum value of the ratio of the total magnetic moment to the total moment of inertia of the moving system, this ratio being a factor in the figure of merit. It also gives numerical results based on experimental data, and claims that the figure of merit has been increased in a particular instrument from the usual value of 4000 or 6000 to about 20,000. The optimum conditions are as follows: (*a*) The moments of inertia of the magnets, taken as rectangular, should together be 1½ times that of the rest of the moving system. (*b*) A certain relation must obtain between these moments of inertia, the mean intensity of magnetisation, I, the ratio of the length to the width of each magnet, r, and the quantity dI/dr. If the moments of inertia obey condition (*a*) this relation becomes:

$$dI/dr = 6/5 \,.\, I/r \,.\, \{r^2/(1 + r^2) - 1/3\}$$

A graphical solution from experimental data gives $r \doteq 4$ for cobalt steel. (*c*) When the total moment of inertia of the magnets has been decided, their number and size should be so chosen as to give the greatest number of magnets in the space available consistent with the condition that the magnets must not interfere with one another by their mutual proximity. It has been found that the distance apart of the magnets should be from three to six times their diameters. C. W. H.

608. *Electrostatic Field of a Triode.* **G. J. Elias, B. van der Pol, Jr., and B. D. H. Tellegen.** (Tydschrift van het Nederlandsch Radiogenootschap. Ann. d. Physik, 78. 4. pp. 370–406, Dec., 1925.)—This paper gives a mathematical treatment of the electrostatic field in a symmetrical triode under certain simplifying assumptions. [See also Abstract 1503 B (1925).] A. W.

ALTERNATING CURRENTS AND MAGNETISM.

609. *Permanent Magnets.* **F. Stäblein.** (Zeits. techn. Physik, 6. 11. pp. 582–588, 1925.)—A *résumé* of some properties of various steels of use in the construction of permanent magnets, *e.g.* 1 % C, 2 % Cr, 5 % W, 10 % Co, 20 % Co and 30 % Co. A description is given of slight modification of the Hartmann-Braun permeameter, together with some elementary considerations on demagnetisation factors and the "shearing" of magnetisation curves. W. V. M.

610. *Magnetic Quality in Crystals.* **J. Forrest.** (Phil. Mag. 50. pp. 1009–1018, Nov., 1925.)—The object of the investigation was (*a*) to discriminate magnetic lattices in crystals and compare these magnetic arrangements with the structures found by X-ray methods; (*b*) to investigate the stability of various arrangements of magnetic doublets. The present paper is only of a preliminary nature, and the full theoretical analysis and experimental details will be given elsewhere [Roy. Soc. Edinburgh, Proc.]. Twenty different crystalline substances, including examples from all systems, have been examined. In some cases the magnetic lattice corresponds with that found by X-ray methods, but this is not always the case. In addition, there are cases in which more than one magnetic lattice satisfies the experimental results. There are also cases where the positions of maximum and minimum inductions in certain crystallographic planes have to be interchanged in order to fit the theoretical calculations to the experimental facts. The stability of various magnetic lattices is also considered on the assumption that the lattices consist of regular arrangements of magnetic doublets. In the cubic system the face-centred system is found to have the greatest possible stability. Next follow in order of descending stability the simple-cube and the body-centred cube. When in the body-centred lattice iron can be both magnetic and non-magnetic. Three particular non-magnetic arrangements are considered with alternate layers oppositely co-directed or containing doublets variously oriented in closed chains. On this view the magneton may be a property of the structure rather than of the molecule or atom.

A. A. D.

611. *The Cobalt Ion in a New Magnetic State.* **A. Serres.** (Comptes Rendus, 181. pp. 714–715, Nov. 16, 1925.)—Cobalt sulphate was dehydrated by heating to redness and subsequently the relation between susceptibility and temperature determined over the range up to 695° C. The results were corrected for the diamagnetism of the sulphion and the quartz envelope. The residual figure for the cobalt shows that it has 26 magnetons. For the same salt Théodorides [J. de Physique, 3. p. 1, 1922] finds 25 magnetons and Honda and Ishiwara [see Abstract 378 (1916)] find 24. This diversity of the magnetic states of the same ion in the same salt has already been noticed both for dissolved and solid salts [G. Foëx, see Abstract 1743 (1925)].

A. A. D.

612. *Diamagnetic and Paramagnetic Turning of the Plane of Polarisation.* **R. Ladenburg.** (Zeits. f. Physik, 34. 11–12. pp. 898–906, 1925.) —In addition to the usual Faraday effect, which depends on the diamagnetic induction action of the fields, there is a paramagnetic turning of the polarisation plane. The turning of the polarisation plane originating in this manner is calculated on the ground of the dispersion theory and Langevin's theory. The characteristics of this paramagnetic turning of the plane of polarisation are that in certain regions of the spectrum a negative rotation can occur, the paramagnetic rotation has an unsymmetrical course on both sides of a proper frequency similar to the refraction quotient—in opposition to the symmetrical course of the diamagnetic rotation—and lastly the paramagnetic rotation has a strong dependence on temperature which is quite analogous to the Curie law of paramagnetism.

A. E. G.

613. *Measurement of Magnetic Fields by Means of a Liquid Jet flowing through the Field.* **G. Schmaltz.** (Zeits. f. Physik, 35. 1. pp. 22–26, 1925.)—A method for the determination of the strength of a magnetic field by the use of a mercury jet is described. The field is traversed by a jet issuing horizontally, and electric current flowing in the jet is adjusted to such a value that the initial horizontality of the jet is maintained throughout its length, so that the gravitational force upon the particles of the jet is just compensated by the force due to the field. J. S. G. T.

RADIOGRAPHY AND ELECTRO-PHYSIOLOGY.

614. *The Potter-Bucky Diaphragm.* **C. H. Holbeach.** (Brit. J. of Radiology, 21. pp. 159–165; Disc., 165–167, Oct., 1925.)—Describes a commercial type of Potter-Bucky diaphragm, and reference is made to previous investigators' work upon subjects such as efficiency, technique, grid factor, grid speed. The generally held view of the production of grid-lines upon plates, as due to a synchronisation of grid speed and the rate of X-ray impulses from the tube, is given. Future development in the use of this grid is foreshadowed. B. J. L.

615. *Investigation of the Movements of the Heart by the Use of the Slit Diaphragm and the Moving Film.* **R. Knox.** (Brit. J. of Radiology, 21. pp. 142–156; Disc., 156–158, Oct., 1925.)—Reider and Rosenthal in 1912 called attention to the possibility of investigating heart movements by radiographical methods, using the well-known method of photographically examining a quantity, varying as a function of time, by means of a fixed slit and moving photographic strip. The present author has utilised this method. His apparatus is described and illustrated. The method also served to investigate the intermittent rate of discharge of the X-ray tube. The effect of current lag in the filament circuit, with respect to the high-tension circuit, was also shown by this method of investigation to be important. Correlation of radiographic images and electro-cardiographic curves was demonstrated. B. J. L.

616. *Constant Continuous Tension in the Production of X-Rays.* **W. Rump.** (Brit. J. of Radiology, 21. pp. 172–177, Oct., 1925. Paper read before the German Röntgen Soc., 1924.)—Deals with comparative measurements of X-radiation quality when produced intermittently and continuously. Measurements show the radiation by continuous methods without filters is more homogeneous and harder, but, after filtration by zinc, the quality of radiation does not differ as regards its method of production. B. J. L.

617. *Kathode-Rays as Substitutes of Potassium.* **H. Zwaardemaker** and **T. P. Feenstra.** (K. Akad. Amsterdam, Proc. 28. 7. pp. 650–655, 1925.)—In physiological heart muscle preparations, when these are entirely deprived of potassium salts, the muscle becomes inactive. Pulsations can be restored by the application of potassium or other radio-active salts, as those of rubidium, thorium, ionium, radium and its emanation. The particular type of the corpuscular radiation from such salts, or its velocity, has no relative effect. The speed of the radiation is only of importance in so far as it determines the penetration of the heart muscle. Prolonged radiation causes cessation of movement.

The authors have utilised Lenard rays to reactivate such heart muscle preparations (in the case of frogs and eels), and details of production and measurement are given. Very powerful radiation is ineffective, but the experiments show that low-speed kathode-rays are equally effective as the corpuscular rays from mesothorium, radium, etc. B. J. L.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

618. *Negative Adsorption. The Surface Tensions and Activities of Some Aqueous Salt Solutions.* **A. K. Goard.** (Chem. Soc., J. 127. pp. 2451–2458, Nov., 1925.)—Determinations of surface tension are made by a drop-weight method of aqueous solutions of varying concentrations of the chlorides of lithium, sodium, potassium and calcium and silver nitrate. With the help of activity values obtained from various data the negative surface adsorption is calculated from the surface tension-concentration curves by means of the Gibbs equation. The results obtained are not in harmony with the supposition that the surface of these solutions consists of a single layer of oriented water molecules, as has been supposed by Langmuir, since the mean thickness of the adsorbed layer varies with the concentration of the solution and with the nature of the salt. An observed decrease in the values for the thickness of the adsorbed layer as the concentration of the solution increases is considered to be due possibly to the "water shells" surrounding the ions becoming smaller or more tightly packed. Evidence is adduced indicating that in concentrated solutions of cadium chloride which have abnormally low activity coefficients, and possibly of silver nitrate, the adsorption is determined by undissociated molecules as well as by ions. J. N. P.

619. *Adsorption Forces and their Electrical Nature. II. The Electrical Moment of the Adsorbed Molecule and the Superficial Energy of the Adsorbent.* **B. Iliin.** (Phil. Mag. 50. pp. 1144–1146, Nov., 1925.)—The electrical moment of the adsorbed molecule can be calculated from the tension of the field of adsorption E_0, which may be determined from the experimental values Q of the heat of adsorption, according to the equations developed by the author [see Abstract 2617 (1925)]. The electrical moment is determined for the adsorption of hydrogen, argon, carbon dioxide, nitrogen, etc., by coal and mica, and is of the order 10^{-18}–10^{-19}. This is compared with the values obtained by other workers employing different methods. The surface energy of coal is calculated to be of the order of 1000 ergs/sq. cm. B. W. C.

620. *Behaviour of Benzene in Presence of Aqueous Solutions: Ultra-violet Absorption as a Function of* pH. **F. Vlès** and **Madeleine Gex.** (Comptes Rendus, 181. pp. 506–509, Oct. 19, 1925.)—The results of earlier work on the absorption spectrum of benzoic acid in relation to the *p*H of its solutions appeared to indicate that the benzene nucleus is capable of being influenced by variation of the value of *p*H [*ibid.*, 180. p. 1342, May 4, 1925]. The ratio between the magnitudes of the ultra-violet absorption of aqueous benzene solutions for two different wave-lengths exhibits sinuous variation with the value of the *p*H of the solution. Various possible causes for this phenomenon are discussed. T. H. P.

621. *Heat of Solution of Gypsum at Maximum Solubility.* **E. Lange** and **F. Dürr.** (Zeits. phys. Chem. 118. pp. 129–139, Oct. 25, 1925.)—The author discusses van't Hoff's formula for the relation between heat

of solution and temperature coefficient of solubility in the case of electrolytes. According to both the simple and the more precise formulæ the heat of solution should become zero at a solubility maximum or minimum. This had been considered as fairly established for gypsum by Roozeboom, but had been questioned by Colson [see Abstract 946 (1925)], who made his experiments by determining the heat of crystallisation of gypsum from supersaturated solutions. The author dissolves $CaSO_4 . 2H_2O$ in water at four temperatures, namely, 22·5°, 27·8°, 33·4°, 37·6°, and finds thus the total heat of solution [see Abstract 2319 (1925)]. The heat of solution, first negative, became zero at 33·4° and then positive, the curve being a straight line. This agrees fairly well with Hulett and Allen, who found a somewhat indistinct solubility maximum near 35°.
H. B.

622. *Influence of Small Traces of Water on Solution Equilibria.* **E. Cohen** and **W. D. J. van Dobbenburgh.** (Zeits. phys. Chem. 118. pp. 37–48, Oct. 25, 1925.)—The solubility of salicylic acid in benzene is found to vary from 1·03 to 1·38 grm. per 100 grm. saturated solution according to the solvent from which the acid is crystallised and the mode of crystallisation. The highest values are obtained after crystallising from water. The effect is attributed to water occluded in the crystals which is not removed by ordinary drying and increases the solvent power of the benzene.
J. N. P.

623. *Influence of Capillary Active Substances on the Surface Tension of Solutions of Salts and their Relation to Ionic Hydration.* **W. Seith.** (Zeits. phys. Chem. 117. pp. 257–284, Sept. 10, 1925.)—The author measured the surface tension of the following capillary active substances: methyl, ethyl, isopropyl, isobutyl and amyl alcohols and aniline, mixed in various concentrations with pure water and solutions of NaCl, $MgSO_4$, LiCl, $MgCl_2$, $BaCl_2$, and urea. The surface tension results agree well with those of Bohr and Stocker, but have a higher degree of accuracy. It is shown that the lowering of the surface tension of the active substance is greater in solutions of salts than with pure water, and the effect increases with the amount of dissolved salt. Plotting the surface tension against the concentration of the active substance gives a series of curves for different amounts of dissolved salt, which curves intersect at a single point. The value of this critical concentration depends on the nature of the salt and of the active substance, and for any given salt it is higher for an active substance possessing more C atoms in the molecule. The effect of the active substance in the salt solution is ascribed to ionic hydration. Between the decrease of the surface tension which an active substance produces in water and solutions of salts a relation exists from which, in the case of insolubility of the salt in the added active substance, the ionic hydration of the salt can be calculated. The surface tension of an aqueous solution which contains a salt and an active substance may be calculated with the help of a single constant, which in the case of the insolubility of the salt in the active substance is the hydration number of ions of the salt.
R. S. R.

624. *Influence of Pressure on the Equilibria in Binary Systems.* **N. A. Puschin** and **J. V. Grebenschtschikow.** (Zeits. phys. Chem. 118. pp. 276–294, Nov. 20, 1925.)—An investigation is made of the influence of pressures up to 4000 kg./cm.^{2} on the freezing-points in the binary systems, consisting of urethane and diphenylamine, urethane and *p*-nitranisol, and sodium and mercury. By the plotting of cooling curves, an evaluation is made at different pressures of the freezing-points of the components and the temperatures of first crystallisation and those of eutectic crystallisation of mixtures, and the values are employed to construct the phase diagrams and derive the eutectic points. It is found, in accordance with thermodynamical requirements, that a change of pressure causes a change in the composition of the eutectic mixture in the direction of an increase in that component which has a smaller value for the term dt/dp. By taking the crystallisation curve of the component which has the smaller value of dt/dp, pressures can be defined which enable the crystallisation of either component alone or of both together. The solubility curves of one and the same compound at different pressures diverge from a parallel direction with increase of pressure. This is in accordance with the van't Hoff relation $K = RT^2/w$. Since the heat of fusion w is not appreciably altered, the change of freezing-point T causes a marked change in the molecular lowering of freezing-point K. [See Abstract 391 (1925).] J. N. P.

625. *Depolymerisation of Cellulose.* **K. Hess.** (Zeits. Elektrochem. 31. pp. 613–614, Nov., 1925.)—Critique of Heuser [Abstract 188 (1926)]. The author showed in 1923 that the methylisation products of hydrocellulose are not chemically uniform derivatives, but are mixtures which in freezing-point determinations by the Raoult-Beckmann method give higher and higher molecular weights as the purification of the hydrocellulose used has been the more prolonged. Molecular weights can in these cases not be determined by the freezing-point method, and Heuser's experiments do not justify his assumption of a depolymerisation of hydrocellulose without chemical scission. [A further reply by E. Heuser and N. Hiemer appears in the Zeits. Elektrochem. 32. pp. 47–50, Jan. 1926.] H. B.

626. *Effect of Differential Aeration on Corrosion.* **A. L. McAulay** and **F. P. Bowden.** (Chem. Soc., J. 127. pp. 2605–2610, Nov., 1925.)—The corrosion of zinc and iron by partly aerated solutions was followed by potential measurements. Four distinct zones were recognised: (1) A zone unwetted by the solution; (2) a zone over which the solution has crept, necessarily well aerated; (3) a zone beneath but close to the surface of the solution, also well aerated; (4) a zone of deficient aeration at greater depths. Zones 1, 2 and 3 were bright, and zone 4 more or less corroded. Standard surfaces were prepared by cleaning sheets of iron and zinc and by electrodeposition, for purposes of comparison. The results obtained showed that both iron and zinc surfaces tend to exist in two normal states, one a more electro-negative state, characteristic of pure metal and corroded region, the other a less electro-negative state, characteristic of aerated regions. The single electrode potential is 75 millivolts for zinc and 200 millivolts for iron. F. J. B.

627. *Influence of Deformations on the Transformations of Some Light Aluminium Alloys.* **L. Guillet.** (Comptes Rendus, 181. pp. 639–641, Nov. 9, 1925.)—An investigation is made of the influence of compression on aluminium alloys after heat treatment. The changes attending heat treatment probably consist in the solution and precipitation in the finely divided condition of the compounds Mg_2Si and Al_2Cu. Rods of duralumin and the alloy Al-Cu-Mn are prepared, annealed, and measurements are made of the influence on the hardness and the different tensile properties of ageing and drawing to different degrees. With duralumin, drawing increases the hardness in a manner similar to that produced by ageing. With Al-Cu-Mn the smallest amount of drawing produces a noteworthy hardening which increases progressively with the amount of drawing. With both alloys the elastic limit approaches the breaking load and the percentage elongation diminishes after drawing. No change in micro-structure can be detected as a result of the transformations. J. N. P.

628. *Influence of Drawing and Quenching upon the Elastic Properties of Some Metals and Alloys.* **A. Portevin** and **P. Chevenard.** (Comptes Rendus, 181. pp. 716–718, Nov. 16, 1925.)—The method of investigation has been previously described by one of the authors [Abstract 587 (1918)]. Measurements are made of the torsion modulus, the thermo-elastic coefficient and the decrement. For a drawn gold wire the torsion modulus increases on heating, reaches a maximum at 225° C. and then diminishes. The thermo-elastic coefficient follows a similar course. The decrement diminishes on heating. Similar results are said to be obtained for normal solid solutions—that is, those possessing no anomalies on heating. Mention is made of the results obtained on the reversible ferro-nickels, but no data are given, and similarly for quenched carbon steels. When these latter are tempered there is a notable change in the decrement at about 200° C. This is not due to the cementite, for it is absent in annealed steels; neither can it be attributed to a new polymorphic transformation in the iron. A. A. D.

629. *Study of the Alloys of Aluminium and Silicon.* **A. Petit.** (Comptes Rendus, 181. pp. 718–719, Nov. 16, 1925.)—Further elements were added to the aluminium silicon alloy known as "Alpax" and their influence upon the mechanical properties found. The particular additions dealt with were magnesium up to 5 %, copper and magnesium up to 5 % together, and zinc and magnesium up to 2 %. The ball hardness, the shearing strength and bending strength for these alloys are given. A. A. D.

630. *Influence of Annealing on the Physical and Chemical Properties of "Lautal."* **K. W. Meissner.** (Zeits. f. Metallkunde, 17. pp. 369–373, Nov., 1925.)—"Lautal" is an aluminium alloy containing 4 % of copper and 2 % of silicon. Specimens were first quenched from 500° C. and subsequently annealed at temperatures up to 200° C. In one series annealing was carried on for 16 hours and in another for 24 hours. After this treatment the ball hardness, elastic limit, breaking load, etc., together with the resistance to corrosion, were found. The results are given in a series of graphs. The ageing of this alloy at ordinary temperature after quenching is slow, but it proceeds more rapidly with rise of temperature. Annealing at about 150° C. leads to a maximum ball hardness and breaking load and a minimum power to resist repeated bendings. A. A. D.

631. *The Recrystallisation of Cold-rolled Silver.* **R. Glocker, E. Kaupp** and **H. Widmann.** (Zeits. f. Metallkunde, 17. pp. 353–357, Nov., 1925.)—Samples of cold-rolled silver were annealed at different

temperatures up to about 900° C. and subsequently their hardness, tensile strength and ductility found. They were also examined by the X-ray powder method. The mechanical tests show the usual recrystallisation range at about 200° C., together with a much vaguer transition range of some sort at about 700° C. The X-ray results are as follows: (1) After rolling the grains have a common orientation with the (112) direction parallel to that of rolling and the (011) plane parallel to the rolled face. (2) Heating to above 200° C. destroys this arrangement, but it does not produce a completely disordered array as has been hitherto supposed. The material recrystallises with the (112) direction parallel to that of rolling and the (113) plane parallel to the rolled face. (3) When heating is carried above 750° C. there is a further recrystallisation and the orientation becomes random. Microscopic examination shows that not until the material enters this range does appreciable grain growth start.
A. A. D.

632. *Photochemical Formation of Hydrogen Chloride.* **G. Kornfeld and H. Müller.** (Zeits. phys. Chem. 117. pp. 242–256, Sept. 10, 1925.)—In contradiction to the results of Baly and Barker [Abstract 1741 (1922)] the experimental data obtained by the authors show that strict proportionality exists between the amount of hydrogen chloride formed photochemically and the intensity of the light effecting the change. This proportionality persisted when the intensity of the light was diminished to $\frac{1}{64}$ of its original value. For a particular mixture with a chlorine pressure of 0·5 atmos., the ratio of the transformed molecules to the number of quanta absorbed was found to be $2{\cdot}54 \times 10^4$, the calculated value for the most sensitive mixtures obtained being $1{\cdot}10 \times 10^5$. It was not found possible to enhance the sensitiveness in any way.
T. H. P.

633. *Velocity of Unimolecular Reactions.* **D. Alexejew.** (Zeits. phys. Chem. 118. pp. 119–122, Oct. 25, 1925.)—It is shown that no fundamental difference exists between gas reactions of the first and second orders, and that the mechanism of a unimolecular transformation may be explained, without assumption of activation resulting from space-radiation, simply by the impacts of the molecules, rich in energy, of the products of the reaction with the ordinary molecules. The part played by radiation is not to be regarded as non-existent, but it is highly probable that no spontaneous decomposition of molecules occurs in gases, and that the distribution of energy among the molecules of a gas proceeds principally with the velocity of sound and not with that of light. T. H. P.

634. *Energy Distribution Law appropriate to the Theory of Chemical Reaction Velocity.* **C. N. Hinshelwood and C. W. Thornton.** (Phil. Mag. 50. pp. 1135–1139, Nov., 1925.)—A mathematical study of bimolecular reactions, a theory of which is developed on the basis of the equation: number of molecules reacting $= Z \,.\, e^{-E/RT}$, where Z = number of collisions, $e^{-E/RT}$ being taken to represent the number of activated molecules in an analysis, from which it is concluded that its use is justifiable until values of E can be determined with greater experimental precision. A. B. C. L.

635. *Mechanism of Chemical Gas Reactions.* **M. Kröger.** (Zeits. phys. Chem. 117. pp. 387–431, Oct. 10, 1925.)—Experiments made with a special apparatus show that, when iodine vapour, under conditions such that collisions of molecules with either other molecules or the walls of the containing vessel are excluded, is passed through a platinum cylinder heated at 1100°, no appreciable decomposition of the iodine molecules is detectable. Attempts were also made, by a method of crossing atomic and molecular rays, to investigate the combination of cadmium atoms and various large polyatomic molecules. T. H. P.

636. *Decomposition of Ozone in Red Light.* **G. Kistiakowsky.** (Zeits. phys. Chem. 117. pp. 337–360, Oct. 10, 1925.)—The decomposition of ozone of high concentration in red light proceeds in accordance with the empirical formula $\frac{dp}{dt} = k_1 . \frac{J_{abs.}\sqrt{[O_3]}}{[O_2]}$, when the total pressure is high, and with the formula $\frac{dp}{dt} = k_2 . J_{abs.}$ when the total pressure is low. Calculation shows that, within the range for which the latter of the above formulæ is valid, two molecules are decomposed per quantum. For ozone-oxygen-helium mixtures the formula $\frac{dp}{dt} = k_1 . \frac{J_{abs.}\sqrt{[O_3]}}{[O_2] + 0{\cdot}13[He]}$ holds, so that, like other gases, helium retards the reaction, but to a less extent than oxygen. This retardation is interpreted in relation to the quenching of the gas fluorescence by added gases. On the basis of certain assumptions, the life of excited ozone is calculated to be 10^{-9} sec. T. H. P.

637. *The Phosphorescent Flame of Carbon Disulphide.* **H. B. Dixon and W. F. Higgins.** (Manchester Phil. Soc., Mem. 69. 2. pp. 19–23, 1924–1925.)—The addition of a small amount of carbon disulphide to a combustible gas is found to reduce greatly the ignition point. By means of a concentric tube apparatus, the following ignition points are determined: Carbon disulphide vapour in air, with less than 0·5 sec. lag, 156° C.; hydrogen under the same conditions, 631° C.; hydrogen and carbon disulphide in equal volumes (instantaneous), 171° C.; hydrogen with 5 % carbon disulphide, 216° C. Mixtures of carbon disulphide with equal volumes of nitrogen or carbon dioxide inflame more readily than the corresponding hydrogen mixture. With methane containing 20 % carbon disulphide partial combustion occurs at a temperature below the ignition point and is accompanied by a luminosity and the formation of a reddish-brown deposit of the compound CS. The luminosity is destroyed by the presence of traces of ethylene, acetylene, or coal-gas, which act as specific "poisons" and also raise the ignition point. Sulphur dioxide and the hydrocarbons have an inhibiting effect to a minor degree, while steam, carbon dioxide, hydrochloric acid and carbon tetrachloride vapour have no effect. A phosphorescent flame similar to that with carbon disulphide is obtained with ether vapour mixed with methane. J. N. P.

638. *The Thermal Decomposition of Nitrogen Pentoxide at Low Pressures.* **H. S. Hirst and E. K. Rideal.** (Roy. Soc., Proc. 109. pp. 526–540, Nov. 2, 1925.)—Unimolecular reactions possess unique interest in view of Perrin's photochemical theory, and it has been denied that true monomolecular reactions ever occur. The thermal decomposition of nitrogen pentoxide appears to fulfil the conditions for such reactions, and the present investigations deal with the order and mechanism of the reaction at very low pressures under conditions where a quantum chain, as postulated by Perrin, or molecular chain of Christiansen and Kramers, would be so long that impact of a quantum or active molecule on the walls of the vessel during the course of a chain must occur. It is found possible to follow the rate of decomposition down to these low pressures, and no retardation in the velocity of decomposition was observed, but, on the contrary, it was found that below a critical pressure, not of the nitrogen pentoxide, but of the total gaseous constituents of the vessel (about 0·25 mm.), the reaction velocity begins to increase, approaching, with decreasing pressure, a value of about five times that obtaining at high pressures. Details of experimental proceedure are given. The observations are most readily interpreted on the assumption that a definite fraction of the activated molecules always undergoes decomposition irrespective of pressure and that a larger fraction of the activated molecules only undergo decompositions if they do not, after activation, suffer collision with other molecules for a period of about 10^{-6} sec. An equation of the type

$$-\frac{dc}{dt} = k_i[1 + k_2 e^{-1\cdot 04 l\,.\,P/\lambda P\lambda}]e^{-24{,}700/RT}\,.\,C$$

is deduced and found to fit the observations. W. V. M.

639. *Waves of Shock and Combustion with Irreversible Residual Combustion.* **E. Jouguet.** (Comptes Rendus, 181. pp. 658–660, Nov. 9, 1925.)—In a former memoir [Journ. de Math. 6. 22, 1906], the author sketched the study of waves of shock and combustion in which the combustion is incomplete and which are followed by an irreversible residual combustion. This study was not reproduced in his " Mechanics of Explosives " because at that time the precise application was not clear. Recent experiments, however, of Audibert and Laffitte seem to indicate that such waves play a part in the detonation of solid explosives and in the period of establishment of the explosive wave in gases. The present paper therefore deals with the mathematical theory of the question, extending to some actual cases the reasoning developed in " Mechanics of Explosives," and adopting the same notation. T. B.

640. *Studies upon Catalytic Combustion. Part I. Union of Carbon Monoxide and Oxygen in Contact with a Gold Surface.* **W. A. Bone** and **G. W. Andrew.** (Roy. Soc., Proc. 109. pp. 459–476, Nov. 2, 1925.)—The rate of combination in a mixture of carbon monoxide and oxygen in theoretical proportions in contact with a gold surface (gauze) in a " normal " state of activity at about 300° is found to be proportional to the pressure of the nitrogen-free mixture [Abstract 108 (1923)]. Either prolonged evacuation or prolonged cooling at the ordinary temperature greatly diminishes the " normal " catalysing power of the surface at the above temperature; subsequent re-activation is a slow process, usually occupying many hours. On the other hand, the catalysing power of the surface, when in " normal " activity, may be highly stimulated by previous exposure to either carbon monoxide or oxygen at about 300°. Although this catalytic combustion is found to depend on the presence of moisture in the system, no hydrogen could be detected in the reacting gases, even when a large excess of carbon monoxide is present. Microscopic examination of the gold surface after the conclusion of the experiments failed to reveal any sign of pitting, the lustre and smoothness of the metal being unimpaired. In explanation of the above results it is supposed that both of the combining gases undergo activation by association with the surface, and that such activation is not confined to superficially adsorbed gas-films of monomolecular thickness, but extends to more deeply occluded gases. Structural changes in the metal possibly play an important part in these phenomena. T. H. P.

641. *Metals for Catalytic Hydrogenation and their Physical Condition.* **O. Schmidt.** (Zeits. phys. Chem. 118. pp. 193–239, Nov. 20, 1925.)—As regards combination with hydrogen four classes of elements may be distinguished: rare gases (no combination); alkali metals, etc. (solid hydrides); carbon, sulphur, phosphorus, etc. (gaseous hydrides); heavy metals and rare earths (solid solutions of hydrogen). In the fourth class the quantity of hydrogen adsorbed increases with the square root of the pressure. The catalytic elements all belong to this class, and are distinguished by a small ionic radius and a large number of electrons in the outer shell; the adsorbed hydrogen is active and atomic. The catalytic hydrogenation of carbon compounds is an ionic reaction; the best catalysts are, in descending order, Ni, Co, Fe, Zn, Cu, all as bivalent ions. Ag, Au, Pb are not suitable. The activity depends upon the surface development, which is estimated by the method of Wolff. When finely divided metals are treated with hydrochloric acid, the smallest particles are first dissolved, and the rate of the reaction becomes steady after about 11 seconds. In the experiments hollow nickel spherules of fairly even size were produced by spraying nickel into water (Schoop process). For given temperature and pressure the adsorption of hydrogen by nickel is proportional to the surface area. At ordinary temperature the hydrogen remains in the surface layer, being held in loose combination; other factors, impurities, solubility of the constituents in the metal phase, etc., are of influence. Technical hydrogenation processes are not described. H. B.

642. *Silver Iodide in the Photo-voltaic Cell.* **A. Garrison.** (J. Phys. Chem. 29. pp. 1406–1407, Nov., 1925.)—Price's criticism of previous paper [see Abstract 2190 (1924)] is shown to be based on a misunderstanding and to be without foundation. Two distinct ways are indicated in which the electrode can act as an iodine electrode. G. A. S.

643. *Action of Visible Light upon the Electrodes.* **R. Audubert.** (J. de Physique et le Radium, 6. pp. 313–322, Oct., 1925.)—If two identical metallic plates are immersed in an electrolyte, and rays of light directed on to one of the plates, then an electric current is set up between the plates. This was first discovered by Becquerel, who concluded that the cause was to be attributed to organic impurities adhering to the metal. Since then a large number of experiments on the subject have been undertaken by various authors, most of whom denied the existence of a photo-voltaic effect with pure metals. On the other hand, recent experiments by Athanasiu [see Abstract 1321 (1924)] led this author to attribute the observed effects either to photochemical alterations or to thermoelectric influences. Experiments by the present author, who has been able to eliminate thermoelectric or photochemical influences, lead to the hypothesis of a photoelectric mechanism, either by emission of electrons or of ions. Absolute cleanliness of the plates is necessary and the metals used must be pure. Platinum and mercury are very suitable, or electrolytically deposited plates of copper, silver, or gold. The source of radiation was an arc of 20 to 25 amps. at 110 volts or a tungsten-nitrogen lamp. The electromotive forces observed were of the order 10^{-6} volts. Independently of the electrolyte used, the surface under radiation always functioned as anode in the case of platinum, copper, or mercury; with gold or silver the radiated surface acted as kathode. Other things being equal, the photo-voltaic effect increased with the frequency of the exciting radiation. T. B.

644. *Potential of Fluorine, determined by Measurement of the Decomposition Potentials of Molten Fluorides.* **O. Ruff** and **W. Busch.** (Zeits. Elektrochem. 31. pp. 614–616, Nov., 1925.)—It is pointed out that the results obtained by Neumann and Richter [see Abstract 205 (1926)] for the potential of fluorine are incorrect and that the extrapolation of the results from about 800° C. to room-temperature, by assuming a straight line function, is not warranted from thermodynamic grounds. F. J. B.

645. *Electrometric Study of the Reactions between Alkalies and Silver Nitrate Solutions.* **H. T. S. Britton.** (Chem. Soc., J. 127, pp. 2956–2970, Dec., 1925.)—The precipitation of AgO with NaHO is studied electrometrically in cells of the type:

Ag	$0 \cdot 1N - AgNO_3$	Saturated KNO_3 solution	100 c.c. of $0 \cdot 02M - AgNO_3$ $+ x$ c.c. of $0 \cdot 1N - NaOH$	Ag.

and the solubility product $[Ag^{\cdot}][OH']$ is calculated. Following a discussion of the behaviour of the Ag electrode in alkaline solutions containing suspended AgO, Rørdam's view that two modifications of AgO exist is shown to be improbable. Lewis' value for the e.m.f. of the O–H cell is held to be low, probably based on a low value for $[Ag^{\cdot}][OH']$. Experiments on the reaction between $AgNO_3$ and NH_3 are made, yielding further evidence of the existence of the complex kation $Ag(NH_3)_2^{\cdot}$.

A. B. C. L.

646. *Thermodynamic Potential Differences at the Boundary of Two Liquid Phases.* **S. Wosnessensky** and **K. Astachow.** (Zeits. phys. Chem. 118. pp. 295–300, Nov. 20, 1925.)—The e.m.f. at the phase boundary, with hydrogen chloride dispersed between the water-phenol and phenol-water phases, is found to increase with the total concentration of HCl: the increase follows a complicated curve, similar to that obtained if a phenolic calomel electrode is used in place of an aqueous electrode. The partition coefficient of HCl between the phases remains constant. These results are due to a difference in the partition of the actual ions, compared with the molecular partition as determined by analysis. With H_2SO_4 instead of HCl the e.m.f. is only measurable at high acid concentrations and increases with the concentration, as does the ratio C_1/C_2 of the acid concentrations in the water and phenol phases. The results illustrate the "salting-out" effect obtained with increasing acid concentrations.

B. W. C.

647. *Electrochemical Actinometers.* **G. Athanasiu.** (Ann. de Physique, 4. pp. 319–424, Sept.–Oct., 1925.)—A general survey of the author's researches on the subject. In a preliminary study of "bare" electrode actinometers it is shown that the resultant e.m.f. produced by the illumination of one electrode in such an actinometer can be explained on the assumption of three causes—polarisation, chemical change, and heating of the electrodes. *Actinometers with one electrode coated with substances sensitive to light.*—A specially constructed radiation filter is used in experiments made to determine the sensitivity curves for radiations of the visible spectrum and of the ultra-violet spectrum. The energy of the radiations is measured by means of a thermoelectric pile. Wave-lengths giving maximum sensitiveness for various substances studied are: Hg_2Cl_2, $0\mu253$; Hg_2Br_2, $0\mu296$; Hg_2I_2, 405; AgI, $0\mu424$; HgS, $0\mu405$; CuO, $0\mu4046$. The positions of these maxima is independent of the electrolyte employed in the actinometer. Photographic plates prepared with the halides of Hg show a maximum sensitiveness over the same region of the spectrum as with the corresponding actinometers. It is incidentally noted that Hg_2Cl_2 and Hg_2Br_2 are fluorescent in ultra-violet light, and that their conductivity is altered. All the facts suggest the explanation of the properties of actinometers on the basis of the chemical change produced by the light in the substances coating the electrodes. In a theoretical discussion of results the increase of conductivity produced by illumination is considered to be due to electronic displacement, and not to be identical with ordinary photoelectric phenomena. The theory of Perrin and Lewis relating the heat of formation and active frequencies can be applied to actinometers, good agreement being obtained between observed and calculated values. A. B. C. L.

648. *A Simple and Efficient Hydrogen Electrode.* **C. P. Sideris.** (Science, 62. pp. 331–332, Oct. 9, 1925.)—A hydrogen electrode consists of a cell made of flat-bottomed glass tube, containing a length of glass tubing reaching to the bottom, where it is bent at 180°, acting as the hydrogen conductor. The hydrogen passes upwards to the platinum electrode, which is a platinum wire coiled into the form of a conical spiral widening at its lower end, and fused into a glass tube containing mercury. The apparatus rapidly attains equilibrium, and may be used for determining the p^H values of soils, fruit juices, etc., with 5–10 c.c. of liquid.
B. W. C.

649. *Radium Rays and the Potential of the Hydrogen Electrode.* **M. Centnerszwer** and **M. Straumanis.** (Zeits. phys. Chem. 118. pp. 240–250, Nov. 20, 1925.)—The authors accept Foerster's view of current generation in the hydrogen electrode and assume the hydrogen in the platinum to be active, atomic and not molecular, inactive as when absorbed by carbon. Calculating the degree of dissociation of hydrogen for ordinary pressures and temperatures after Isnardi, Langmuir and Nernst, they find the value $2 \cdot 3 \times 10^{-32}$, which they regard as improbable. If ionisation of molecular into atomic hydrogen take place at the expense of the former, this effect should, in the electrode, be the more noticeable the lower the degree of dissociation. Experiments on the effect of radium on the potential of the hydrogen electrode were made in two ways. In the first, two electrolytic cells were coupled in opposition, and the one cell was exposed to the radiation from radium bromide; in the second an Ostwald cell was used, and the ionisation current between the condenser plates was observed. Contrary to expectation, no effect whatever of the radiations was observed in either case. H. B.

650. *Electrical Dispersion of Liquids.* **V. Cofman.** (J. Phys. Chem. 29. pp. 1289–1302, Oct., 1925.)—The phenomena accompanying the passage of an electric current through contiguous immiscible electrolytes were investigated. The solutions employed were nitrobenzene and potassium triodide, and water solutions of potassium iodide, magnesium sulphate, sodium acid phosphate, sodium diethyl-barbiturate, tetraethyl ammonium iodide, and potassium polyiodide and silver nitrate. Other solvents besides nitrobenzene were tried: amyl alcohol, olive oil, guaiacol. The results showed that the transfer of electricity from one electrolytic phase to another does not take place in every case by means of ions only, but that it is also carried out by means of electrons and by larger complexes of ions and solvent. A tentative theory is put forward to explain the various phenomena observed. F. J. B.

651. *Calculation of the Equivalent Conductivity of Strong Electrolytes at Infinite Dilution. Part I. Aqueous Solutions.* **A. Ferguson** and **I. Vogel.** (Phil. Mag. 50. pp. 971–985, Nov., 1925.)—The conductivity of a number of strong electrolytes was calculated for infinite dilution. The Storch equation $K = (C\alpha)^n/C(1 - \alpha)$ was utilised and the experimental data of Kohlrausch and others was employed for the purpose of calculation. For details the original paper must be consulted. F. J. B.

652. *Electrical Conductivity in Benzene Solutions.* **Sophie Jakubsohn.** (Zeits. phys. Chem. 118. pp. 31–36, Oct. 25, 1925.)—An investigation is made of the electrical conductivity of the system $AlBr_3 . H_2S$ in benzene. A perceptible conductivity is only obtained with solutions containing a concentration of about 20 % of the complex, and the value increases with increasing concentration, at first slowly and then more rapidly. With a concentration of 53·99 % the specific conductivity at 25° C. is $3{\cdot}54 \times 10^{-4}$. The molecular conductivity and molecular weight increase with increasing concentration, and a parallelism is found between these values of the molecular weights derived from the conductivity and those calculated from cryoscopic measurements. The results indicate that association of the molecules or solvation occurs. By electrolysis with direct current hydrogen is separated at the kathode, and at the anode bromine, which then reacts to form complex derivatives. The decomposition voltage is measured for a 45 % solution and found to amount to 0·74 volt at 25° C. J. N. P.

653. *Conductivity and Electrolysis of Iodine Trichloride in Acetic Acid.* **B. P. Bruns.** (Zeits. phys. Chem. 118. pp. 89–98, Oct. 25, 1925.)—Iodine trichloride dissolves in dry acetic acid to the extent of 33 % to form a clear solution. In presence of traces of water a precipitate of iodic acid is formed. Though acetic acid is of low dielectric constant, solutions in it of iodine trichloride are found to possess a considerable specific conductivity amounting to 10^{-2} at high concentrations. The molecular conductivity falls with increasing dilution, reaching a minimum value at a dilution of 10 litres and beyond this increasing so that the value at high dilutions is approximately the same as at high concentrations. Curves plotted to show the influence of temperature on conductivity possess breaks at temperatures between 20° and 30° C. The effects of concentration and temperature which are observed are attributed to the formation and decomposition of complexes between solute and solvent.

On electrolysis the amount of chlorine separated is double that corresponding to the electrochemical equivalent. The decomposition voltage is very small. The ions formed consist apparently of ICl_3^{--} and $(CH_3COOH)_n^{--}$. J. N. P.

654. *Influence of Iodine on the Conductivity of Aqueous Solutions of Cadmium Iodide and of Potassium Iodide.* **H. Bruns.** (Zeits. f. Physik, 34. 10. pp. 751–765, 1925.)—With concentrations of cadmium iodide below about 5 % the conductivity is not appreciably altered by the addition of the small amount of iodine which is soluble in the aqueous solution. With high concentrations of the salt, however, the conductivity is increased in proportion to the concentration of the added iodine. With potassium iodide the conductivity is in all cases depressed by the addition of iodine, and the effect is in proportion to its concentration. The fall in conductivity with potassium iodide is attributed to the formation of complexes between potassium iodide and iodine, from which the difficultly mobile I_3 ion is yielded, and the rise in conductivity with cadmium iodide is explained by the assumption that concentrated solutions normally contain aggregates of the composition $(CdI_2)_n$ and that these are broken down by iodine, leading to smaller aggregates and an increase in the number of ions, which effect more than counteracts the fall in conductivity produced by the subsequent formation of I_3 ions. The results are in agreement with the observation of Schmidt [Abstract 98 (1925)] that the addition of iodine increases the thermionic emissivity of cadmium iodide. The cadmium iodide molecule is considered to dissociate into Cd^{++} and $Cd_{n-1}I_{2n}^{--}$, and through the comparative immobility of the negative group emits only positive ions. J. N. P.

655. *Movement of Colloidal Particles in Alternating Fields of Different Frequencies.* **O. Blüh.** (Ann. d. Physik, 78. 2. pp. 177–194, Nov., 1925.)—Measurements are made of the oscillating movement of charged colloidal particles of a silver hydrosol in an alternating electric field of varying frequency. The mobility is defined by the established relation $v = BK$, where v is the velocity of the particle under the influence of the field K and B its mobility. If the mobility is independent of the frequency, the following relation, which is in accordance with the double layer theory of Helmholtz-Smoluchowski, will hold: $H\nu = \text{const.}$, where H is the amplitude of the particle and ν the frequency of the field. Observations of the length of path described by particles of different sizes are made with a Zeiss cardioid ultramicroscope. A constant field of 44 volts is applied, and the frequencies varied from 50 to 308 cycles.

The value of $H\nu$, and hence the mobility, shows a definite increase with increasing frequency. The results are attributed to the particles moving ahead of their surrounding envelopes of water, when under the influence of high-frequency oscillations, whereby the apparent radius of the particles and their viscosity is lowered. The influence of electro-osmotic movement of the liquid in contact with the walls and other possible sources of experimental error are considered. Some parallel results which have been obtained with aerosols are cited. J. N. P.

656. *The Occurrence of Dwi-Manganese in Manganese Salts.* **V. Dolejšek** and **J. Heyrovský.** (Nature, 116. pp. 782–783, Nov. 28, 1925.)—By means of an automatically registering "polarograph" a

curve is traced showing the rise of current with increasing potential. With purified solutions of manganous sulphate humps in the curve at $-0·57$ volt and $-0·98$ volt from the calomel zero are obtained. From the different heights of these humps the impurity is estimated as $0·5 - 4·0 \times 10^{-4}$ equivalents per litre, and is considered to consist of eka-manganese (43) and dwi-manganese (75). The former of these is removed by precipitating with hydrogen sulphide in acid solutions. The dwi-manganese is obtained in concentrations up to about 2 %, together with manganese, by leaving the solution for two days in contact with a galvanic couple of platinum and manganese amalgam and dissolving in hydrochloric acid the deposit which forms on the platinum foil. A description is given of the characteristic spectral lines given by the metal.
J. N. P.

657. *Some Electrode Phenomena in Electrolysis.* **J. A. Crowther** and **R. J. Stephenson.** (Phil. Mag. 50. pp. 1066–1079, Nov., 1925.)—The increase in resistance of an electrolytic cell was investigated, by means of a point electrode, consisting of a piece of platinum wire fused into a glass tube and cut off close to the glass. The search point was moved about so as to explore the condition of the electrode during the passage of the current. The electrolyte was sulphuric acid of varying strengths, sp. gr. 1·050 to 1·210. Evidence was obtained to show that contact or transfer resistance exists between an electrolyte and a polarisable electrode immersed in it. This resistance was shown to be inversely proportional to the pressure on the cell. From this it is deduced that the transfer resistance consists of a thin gas-film. If the current density exceeds a certain critical value the resistance at the electrode is very largely increased. It is suggested that this is due to the liquid being thrown into the spheroidal state by the heat generated in the transfer resistance owing to the passage of the current through it. [See also Abstract 2360 (1925).]
F. J. B.

658. *Electrolytic Reduction of Aldehydes. Part I. Formaldehyde and Acetaldehyde.* **G. Shima.** (Kyoto Coll. Sci., Mem. 9. 3. pp. 183–196, Nov., 1925. In English.)—The electrolytic reduction of formaldehyde and acetaldehyde in an acid and an alkaline solution was studied with the object of learning the difference in their kathodic reactions. On comparing the various influences exercised by electrode materials, current density, temperature, concentration of acid, etc., it was found that though both aldehydes give the corresponding alcohol as the chief reduction product, formaldehyde is reducible with greater difficulty, the current efficiency for its reduction to methyl alcohol being only 50 %, while that for the reduction of acetaldehyde into ethyl alcohol is 75 %. It was also found that the presence of a large quantity of aldehydes in the kathode solution greatly lowers the yield of alcohols, as the aldehydes undergo polymerisation and change into resinous matter at the kathode. The most favourable conditions for the formation of alcohol from acetaldehyde were established.
AUTHOR.